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JOURNAL OF ECONOMIC BIOLOGY

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THE
JOURNAL OF ECONOMIC BIOLOGY.

ON THE AFFINITIES OF THE SUB-FAMILY *CORETHRINAE* OF THE *CULICIDAE*.

By

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Owing to the great importance of the *Culicidae* in relation to Malaria and other diseases our knowledge of that family has leapt forward with unprecedented rapidity. Its classification, however, is still on an unsatisfactory basis, and there is an embarrassing difference of opinion with respect to its division into sub-families. Partly from the point of view of convenience, and partly from an insufficient understanding of biological characters, several recent writers advocate the separation of the *Corethrinae* from the rest of the *Culicidae* as a distinct family. Rondani in 1856 was, I believe, the earliest writer to elevate the *Corethrinae* to family rank. Coquillet and other recent writers also similarly propose this system of classification. I am in entire agreement with Colonel Alcock[1] in his recent article on the Classification of the *Culicidae*, wherein he protests against this procedure. In 1908[2] I endeavoured to point out the closeness of the relationship that exists between the *Corethrinae* and the rest of the *Culicidae*, but apparently my paper has escaped Colonel Alcock's notice.

It seems highly probable that, as our knowledge of the *Culicidae* extends, a rational classification of the family will have to be based on a combination of both larvae and imaginal characters, and their larvae exhibit exceptionally well-defined features for the purpose. Such a system of classification has already been attempted by several writers. At present, however, it is necessary that the ethology and morphology of the larvae should be more critically studied. It is required to ascertain how far any structural feature

[1] Remarks on the Classification of the *Culicidae*, &c. Ann. Mag. Nat. Hist., 1911, ser. 8, vol. 8, p. 240.

[2] On the Larval and Pupal stages of *Anopheles maculipennis*. Parasitology, 1908, pp. 122, *et seq.*

may be correlated with a particular mode of life. In some instances it seems almost impossible to discriminate between those characters which have been developed, perhaps recently, by adaptation, and those which are to be regarded as phylogenetic or morphological characters. Until this distinction is clearly recognised it appears to me obvious that the application of larval characters for the purposes of generic classification loses much of its value. As an example may be mentioned *Aedes fuscus*, Osten-Sac., whose larva is of the general *Culex* type, and possesses four narrow lanceolate gills and a short siphon.[1] According to Felt[2] it bears so close a resemblance to the larvae of *Culex sylvestris*, Theob., and *C. impiger*, Walk., that it is difficult to separate them. The larvae of *Aedes smithii*, Coq., on the other hand, differs so markedly from that of *A. fuscus* that the systematist, if he were relying solely on larval characters, would unhesitatingly place it in a separate genus! The larva of *A. smithii* possesses but a single pair of anal gills which are broad and rounded at their apices. In possessing but two such gills, it is, I believe, unique among Culicid larvae. It further differs in the form of the thorax and siphon, its mandibles have but a single bristle or curved spine at their apices, and, furthermore, the pecten is absent. Dyar and Knab[3] have contributed an important paper in which they classify the larvae of the New World Mosquitoes independently of their imagines. This is a step towards an ideal method of treatment, but no classification founded solely on either larval or imaginal characters alone will, to the best of my belief, stand the test of time. A practical classification, taking into consideration the characters of the imagines, and easy of application is necessary from the standpoint of medicine. Its primary feature should be that it allows of the identity of any particular species of mosquito to be ascertained with comparative ease. From the standpoint of the biologist such a system would quite likely be voted as unscientific, and a more rational classification would appear to him to be a necessity. There is no reason, however, why a natural system of classification should not eventually prove easy of application to practical workers in the field engaged in medical researches. Its primary feature is that it should take into account characters afforded by the earlier as well as the imaginal stages.

[1] *Vide* Dyar:—Illustrations of the Larvae of North American *Culicidae*. Journ. New York Entom. Soc., 1902, vol. x, p. 197.

[2] Mosquitoes or *Culicidae* of New York State. Bull. N.Y. State Mus., No. 79, Entom. 22, 1904, p. 340.

[3] The Larvae of the *Culicidae* classified as independent organisms. Journ. New York Entom. Soc., 1906, vol. xiv, No. 4, p. 169.

It is owing to undue stress being laid upon the characters afforded by the perfect insects, that the *Corethrinae* have been regarded as separate and distinct from the remaining members of the *Culicidae*. It is from the standpoint of the biologist that a protest against this cutting adrift of the *Corethrinae* is most needed. Great stress has been laid on the reduced condition of the mouth-parts which are not adapted for piercing. Additional features have also been found in the neuration of the wings, and the absence of scales from the latter. To be rational those who advocate this separation should similarly remove the genus *Phlebotomus* and its allied forms from the remainder of the *Psychodidae*, which have no piercing mouth parts, and elevate them to the dignity of a new family! The genus *Pelorempis*, though agreeing with the *Corethrinae* in the form of the proboscis, resembles the *Culicinae* in possessing scales to its wings. When we take into consideration the larvae, closer bonds of union are demonstrable. The extreme type of larval development among the *Corethrinae* is found in *Chaoborus*.[1] Its larva is a highly specialised organism, almost perfectly transparent, the extremities of the jaws and the pigmented eyes and air reservoirs being the only parts that catch the unaided eye. The head is much prolonged anteriorly, carrying the antennae with it. The pharynx takes the form of an eversible tube, and the last abdominal segment carries a set of remarkable posterior hooks, and two pairs of anal gills. Respiration is apparently cutaneous for there are no traces of spiracles present, and the tracheal system exists in a greatly reduced and much modified condition. The latter consists of a pair of longitudinal tracheal trunks extending through the greater part of the length of the animal. The tracheal system does not contain air, except in the regions of the thorax and the seventh abdominal segment. The larva of *Corethra*[2] forms a connecting link between that of *Chaoborus* and a typical Culicid larva. The intermediate condition is especially well demonstrated by the tracheal system which, although it has undergone a certain degree of reduction, is much more developed than in *Chaoborus* and, moreover, spiracles are present. *Corethra* resembles *Chaoborus* in the form of the larval antennae, though the head is not prolonged anteriorly.[3] The larva of *Corethra karnerensis* is remarkable in having the extremity of

[1] *Chaoborus*, Lichtenstein = *Sayomyia*, Coquillet. (*Vide* Coquillet, Proc. U.S.Nat. Mus., 1910, vol. 37, p. 603 and Brunetti, Rec. Ind. Mus., 1911, vol. iv, pp. 317, and 1911 vol. vi, p. 227).

[2] *Corethra*, Meigen = *Mochlonyx*, Loew.

[3] On this point *vide* Meinert. De eucéphale Myggelarver. Vidensk. Selsk. O Raekke, Naturvid. og. math. Afd., 1886, III, Tab. II.

the last segment bordered by a whorl of short, closely set, recurved, fleshy processes.[1] The genus *Pelorempis* is still imperfectly known. Its larva resembles those of *Chaoborus* and *Corethra* in possessing elongate antennae provided with stout spines set at an angle with their long axes. The general shape of the head resembles that of *Corethra*, but the maxillae resembles those of *Chaoborus*. There is no respiratory siphon present, and the spiracles are supported by a chitinous skeleton resembling that of *Anopheles*.[2] In its respiratory system it bears a very marked resemblance to that of *Anopheles*, and *Pelorempis*, consequently appears to be a synthetic type as regards its larval characters, exhibiting features common to both the *Corethrinae* and *Anophelinae*. The larvae of both *Eucorethra* and *Corethrella* resemble *Corethra* much more closely than *Chaoborus*, and both possess a well developed tracheal system, resembling that of *Culex* and opening at the extremity of a short siphon.

In these few remarks I trust that I have been able to demonstrate that there is, in my opinion, little real justification for separating the *Corethrinae* as a family distinct from the rest of the *Culicidae*. The above-mentioned grounds for this conclusion may thus be briefly summarised :—

The genus *Pelorempis* of the *Corethrinae* agrees with both *Chaoborus* and *Corethra* in the form of the proboscis of the imago. In possessing scales to the wings it resembles the *Culicidae*. Its larva exhibits characters belonging to both the *Corethrinae* and *Anophelinae*. The larva of *Chaoborus* is a highly specialised type bearing no close resemblance to any other forms. The larvae of the remaining genera of the *Corethrinae* are intermediate in character between that genus and the general *Culex* type of larva. In the opinion of the writer no hard and fast lines of demarcation can be drawn between the *Corethrinae* and the remaining *Culicidae* sufficient to warrant the elevation of the former to family rank.

December 14th, 1911.

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[1] Felt. *loc. cit.* p. 353.

[2] Johannsen. Aquatic Nematocerous Diptera. Bull. New York State Mus., No. 68, Entom. 18, 1903, p. 404.

RECORDS OF SOME BIRD-LICE *(MALLOPHAGA)*.—I.

By

RICHARD S. BAGNALL, F.L.S., and WILLIAM HALL.

With 3 Figures.

We are gathering material for a proposed account of the insect ecto-parasites of the mammals and birds, both wild and domestic, of the North of England, paying special attention to the *Siphonaptera* (Fleas), *Anoplura* (Blood-sucking lice) and *Mallophaga* (Biting lice), but not neglecting the smaller groups, such as the Dipterous family *Hippoboscidae* or the Hemipterous family *Cimicidae*, etc.

As it will be some years before we can feel justified in publishing our list of *Mallophaga*, we propose, in the present series of "Records," to give short notes on certain rare species, especially those which so far as we know have not been previously recognised in this country.

In the following notes we are able to bring forward for the first time as British, *Docophorus acutipectus*, Kellogg, *D. cordiceps*, Piaget, *Nirmus lineolatus*, Nitzsch, *N. punctatus*, Nitzsch, *N. dispar*, Piaget, *Oncophorus minutus*, Nitzsch, *Goniocotes chrysocephalus*, Giebel, *Lipeurus anseris*, Gurlt, *L. longicornis*, Piaget, *Menopon biseriatum*, Piaget, *M. brevipalpe*, Piaget, *M. phaeostomum*, Nitzsch and *Colpocephalum bicolor*, Piaget. Of these *D. acutipectus*, Kellogg, described by Professor Vernon L. Kellogg from a Californian bird, and *N. dispar*, Piaget, are perhaps the most interesting, and certainly the most unexpected captures.

We have found it necessary to propose a new name for Piaget's *Lipeurus brevicornis*, the name *brevicornis* having been used by Denny, though Denny's species was somewhat doubtfully regarded by Piaget as a synonym of *longicornis*, Piaget. We would have associated the author's name with his species, but we find that Taschenberg has already described a *Lipeurus piageti*.

We would express our thanks to Professor Kellogg, who has kindly consented to identify or confirm our identification of specimens submitted to him, and throughout our notes we have affixed "*teste* Kellogg" in brackets after the names of all species he has examined for us. The new British forms being noted by an asterisk. In the course of these notes we more particularly express our thanks to those friends who have so kindly sent us material.

DOMESTIC BIRDS.

GOOSE (*Anser domesticus*). Fatfield, Co. Durham.

* **Lipeurus anseris,** Gurlt. (*teste* Kellogg).

Gurlt, Mag. f. d. ges. Thierheilk,[1] viii, p. 426, pl. iv, figs. 12 & 13.

This fine distinct species was unknown to Piaget, and the identification of our specimens has been confirmed by Prof. Kellogg. A number occurred about the wing feathers of a goose that died recently at Fatfield, and also on its living mate.

PEAFOWL (*Pavo cristatus*). Fence House, Co. Durham.

* **Menopon phaeostomum,** Nitzsch. (*teste* Kellogg).

Piaget, Les Pédiculines, 1880, p. 466, pl. xxxviii, fig. i.

We have seen a number of this species from the head of a peacock, where they ran about with great quickness and chiefly affected the earholes and the eyes. This species is recorded from two other kinds of peafowl.

TURKEY (*Meleagris gallopavo*). Biddick, Co. Durham.

Goniodes stylifer, Nitzsch.

Common.

* **Menopon biseriatum,** Piaget.

Piaget, Les Pédiculines, 1880, p. 469, pl. xxxvii, fig. 2.

A few examples (females) with *G. stylifer*. The same species is found also on the common fowl and the pheasant.

WILD BIRDS.

PHEASANT (*Phasianus colchicus*). County Durham.

* **Goniocotes chrysocephalus,** Giebel.

Piaget, Les Pédiculines, 1880, p. 232, pl. xix, fig. 7.

One example.

PARTRIDGE (*Pedix cinerea*). County Durham.

Goniodes dispar, Nitzsch.

A few examples.

Menopon pallescens, Nitzsch (=*perdicis*, Denny).

Common.

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[1] Ueber die auf Haussäugethieren u. auf Hausvögeln lebenden Schmarotzinsecten.

WATERHEN (*Gallinula chloropus*). (*a*) Tynedale, Northumberland.

***Oncophorus minutus,** Nitzsch.

Piaget, Les Pédiculines, 1880, p. 215, pl. xviii, fig. 2.

Three examples. The bird was sent to us by Mr. Walter Lee, of Corbridge. There is a possibility of Denny's *Nirmus cuspidatus* (*scopoli*) from the Water Rail being the same species as the one we have before us.

(*b*) Fatfield, Co. Durham.

Menopon tridens, Nitzsch. (=*scopulacorne*, Denny).

A few, together with a minute *Nirmid* (probably *O. minutus*) not yet satisfactorily identified.

LAPWING (*Vanellus vulgaris*). Fatfield, Co. Durham.

***Docophorus cordiceps,** Piaget. (*teste* Kellogg).

D. cordiceps, Piaget, Les Pédiculines, 1880, p. 80, pl. vi, fig. 2.
D. temporalis, Giebel, Piaget, *l.c.*, 1880, p. 82, pl. vi, fig. 3.

A single example. Identification confirmed by Professor Kellogg, who tells us that *temporalis* must be regarded as a synonym.

Menopon furvus, Nitzsch.

Common.

Colpocephalum ochraceum, Nitzsch. (*teste* Kellogg).

Numerous.

TURNSTONE (*Strepsilas iterpres*). Farne Islands, Northumberland.

***Colpocephalum bicolor,** Piaget.

Piaget, Les Pédiculines, 1880, p. 561, pl. xlvii, fig. i.

Examples of both sexes, together with numerous specimens of *N. furvus*, N.

***Nirmus dispar,** Piaget. (*teste* Kellogg).

Piaget, Les Pédiculines, 1880, p. 174, pl. xiv, fig. 7.

A single *Nirmus* new to us has been identified by Professor Kellogg as this species. Previously recorded from two species of Cormorant, *Carbo sulcirostris* and *Phalacrocorax capensis*.

LESSER BLACK-BACKED GULL (*Larus fuscus*). Farne Islands, Northumberland.

Nirmus punctatus, Nitzsch.

Piaget, Les Pédiculines, 1880, p. 200, pl. xvi, fig. 4.

A beautifully marked form. We have taken it in numbers on this bird. It has previously been recorded from other species of *Larus*.

Docophorus lari and other species, including what we believe to be *Docophorus acutipectus*, were also taken.

CORMORANT (*Phalacrocorax carbo*). Farne Islands, Northumberland.

Docophorus bassanae, Denny.

Several. We have also specimens taken by Mr. W. M. Charlton from the gannet.

* **Lipeurus longicornis**, Piaget.

Piaget, Les Pédiculines, 1880, p. 334, pl. xxvii, fig. 3.

Common about the wing feathers and under the wing. Piaget refers Denny's *L. brevicornis* (from the Shag, *P. cristatus*) to this species with some doubt, but from Denny's description and figures (Monographia Anoplurorum Britanniae, 1842, p. 181, pl. xiii, fig. 8), it will be seen that the two species *longicornis* and *brevicornis* are amply distinct. We attach sketches of the antennae for comparison and in an addendum propose a new name for the *L. brevicornis* of Piaget, described from two exotic species of cormorant.

* **Menopon brevipalpe**, Piaget.

Piaget, Les Pédiculines, 1880, p. 498, pl. xl, fig. 5.

In large numbers, on all parts of the bird; a very active insect.

* **Nirmus lineolatus**, Nitzsch.

Piaget, Les Pédiculines, 1880, p. 199, pl. xvi, fig. 3.

One specimen, most probably accidental, as it is only recorded from species of *Larus*. It is a well-marked form, and comes near *punctatus* recorded above.

PUFFIN (*Fratercula arctica*). Farne Islands, Northumberland.

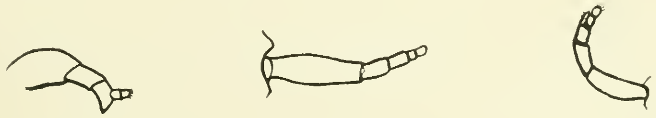
Docophorus celedoxus, Nitzsch.

In numbers. This species is also recorded from the common guillemot (*Uria troile*) and the razorbill (*Alca torda*).

* **Docophorus acutipectus,** Kellogg (*teste* Kellogg).

Kellogg, New Mallophaga, 1896, pt. i, p. 84, pl. 3, fig. 4.

We separated two or three examples of a very distinct *Docophorus* from the *celedoxus* recorded above, and submitted them to Professor V. L. Kellogg, who has identified the species as his *acutipectus* hitherto only known from *Ceratorhina monocerata* (California, U.S.A.). It is therefore an interesting and unexpected addition to the European Fauna.



1. 2. 3.

Fig. 1.—*Lipeurus brevicornis*, Denny (*nec* Piaget). Antenna of male. (After Denny).
Fig. 2.—*Lipeurus longicornis*, Piaget. Antenna of male. (Original).
Fig. 3.—*Lipeurus confusus*, Bagnall and Hall. Antenna of male, (After Piaget).

ADDENDUM.

Lipeurus confusus, Bagnall and Hall, *nom. nov.*

L. brevicornis, Piaget (*nec* Denny), Les Pédiculines, 1880, p. 337, pl. xxvii, fig. 6.

The name *brevicornis* is pre-occupied. The present species, Piaget's *brevicornis* is described from *Carbo* (*Phalacrocorax*) *sulcirostris* from the Celebes and from *Carbo africanus* from Dembea.

AN EXAMINATION OF THE CAUSES WHICH HAVE LED TO THE FAILURE OF THE BIOLOGICAL WORK RECENTLY UNDERTAKEN ON THE CEYLON PEARL FISHERIES.

By

H. LYSTER JAMESON, M.A., D.Sc., Ph.D.

At the sixth annual ordinary general meeting of the Ceylon Company of Pearl Fishers, Ltd., held in London on Monday, December 18th, 1911, as reported in the *Financial News* for December 19th, the Chairman, the Right Hon. Sir J. West Ridgeway, formerly Governor of Ceylon, summed up the position of the enterprise as follows:—

"I am sure I need hardly say that my colleagues and I regret exceedingly that we meet you to-day under such adverse conditions. The accounts, which have been in your hands for some days, speak for themselves, and there is nothing in them that requires explanation. The main fact—and it is a very unpleasant one—is that we carry forward an adverse balance of £118,517 5s. 4d. This includes £84,000 paid to the Ceylon Government as rent during barren years. Altogether we paid to the Ceylon Government in rent nearly £125,000. You know the causes which have led to this result. An entire absence from the pearl banks for some years past, not only of oysters, but of almost all forms of marine life, has prevented us from holding a fishery since 1907. The failure of this venture has been one of the greatest disappointments of my life. When, in my speech at our first annual meeting I stated that this business was a speculative one, but a speculation prompted, encouraged, and assisted by science, I, in common with my colleagues and those who first conceived the enterprise, had no doubt that the methods recommended by the scientific advisers of the Government for eliminating barren years and making the fisheries a regular annual event, would achieve that object. These views were shared by the representatives of the Government, as shown by the utterances of the representative of the Colonial Office in the House of Commons, when the prospects of the company were represented in optimistic terms. We have all through the piece followed the recommendations of the scientific advisers of the Ceylon Government with scrupulous fidelity, but as I have before told you, practical experience has proved these theories to have been based on insufficient information as to the causes which led to the destruction of spat, and consequently the remedies based upon those theories have proved to be futile. By costly experiments we have

since established the fact that the ravages of fish are the chief cause of such destruction, and deducing therefrom that the protection of the deposits by wire netting is the only remedy, we have been singularly unfortunate in not being able to bring this preventive into operation, owing to the barrenness of the banks. We nevertheless hoped that this year's inspection would disclose spat deposits, and so enable us to apply this remedy, in which case, as we have already informed you, the Government of Ceylon had expressed their willingness to reconsider our application for a modification in the terms of our lease. In their annual report the Board stated that the results of the inspection would probably not be received in time to report it to this meeting. It came to hand, however, quite unexpectedly a few days ago, by cablegram, and I deeply regret to say that no oyster deposits have been found.

"At this moment there is nothing encouraging that I can say. The company's capital is approaching towards exhaustion, and under the lease, the rent for 1912 becomes payable on or before the 1st of next month. As it amounts to nearly £21,000, it would be impossible to meet it without calling up the remainder of the company's capital, which the directors are extremely reluctant to do. . . ."

In reply to a shareholder, he added:—

"That he had on several occasions pointed out that theirs was a speculative undertaking, based on the advice of scientists, who reported to the Ceylon Government that the disappearance of spat was due to certain causes, and who recommended certain remedies. Unfortunately, those methods proved a failure. Year after year there had been no spatfall, and the company could not protect spat which did not exist."

The Chairman's speech thus throws the blame of the failure of this Company, founded in March, 1906, with a capital of £165,000, and committed to an annual outlay on rent and improvements representing something like three times the probable average annual returns of the fisheries, as calculated on the basis of the revenue derived from them since the beginning of the nineteenth century, to the failure of biological science as applied to the industry.

Unpleasant things were said about "scientific experts" by disappointed shareholders in the discussion that followed the Chairman's address, but these were, perhaps fortunately, not reported by the Press representatives.

It is to the interest of every economic biologist to enquire whether this regrettable failure can fairly be attributed to biological science. Hence this paper. I will begin with a brief review of the history of the enterprise.

The Pearl Fisheries of Ceylon, which have been carried on on practically the same lines for thousands of years, are dependent upon the fact that certain areas of sea bottom in the Gulf of Manaar, known as "Paars," are periodically covered with copious deposits of the oriental pearl oyster, *Margaritifera vulgaris*, Schum. These oysters, if they survive and reach maturity, can be fished in quantities and yield an abundance of fine pearls.

When such a fishery takes place, a few weeks often suffice to clear the ground, for all practical purposes, of payable oysters; and the number fished may be anything from a few hundreds of thousands to many millions of oysters, and the Government's share in the proceeds anything from a few thousand rupees up to a million rupees and over. The record was broken by the two great fisheries of 1904 and 1905 yielding respectively 1,376,745 rupees and 2,405,645 rupees and surpassing all previous records, the only other fishery which yielded a return of more than a million rupees being that of 1814.

The outstanding feature of the Ceylon Pearl Fisheries has always been the intervals of barren years which intervene between fisheries, or series of fisheries. Sometimes these intervals amount to one or two years only, but others have been much longer, the longest on record being one of twenty-eight years during the Dutch era in Ceylon, namely from 1768-1796. Prior to the fishery of 1903 there had been a break of some twelve years.

The effect of these blank periods has been that while individual fisheries have yielded large revenues, the average annual return calculated over any long period is relatively small. Thus the average for the whole of the 19th century works out at about 120,000 rupees per annum, while even if the whole period from 1801 up to the year preceding the formation of the Company, that is to say, 1905, be taken, which period includes the three great fisheries in 1903, 1904, and 1905, the average return is only about 156,000 rupees.

In 1900, after a ten years' interval of barren years, the Government of Ceylon began to inquire whether any steps could be taken to render the fisheries more frequent and reliable. Professor Herdman's Mission which ultimately (if indirectly) seems to have led to the formation of the Company, was the outcome of this inquiry.

Professor Herdman was selected on the advice of the Council of the Royal Society and Professor (now Sir) Ray Lankester, and, after an examination of the records, he proceeded to Ceylon early in 1902 to carry out some practical researches on the ground. He took with him as his assistant, Mr. James Hornell, and Mr. Hornell remained behind him in Ceylon when he returned to his duties in Liverpool after some three

months in the island. The subsequent work was carried on by Professor Herdman in Liverpool with Mr. Hornell's assistance in Ceylon. The results of Professor Herdman's investigations were published by the Royal Society in a "Report on the Pearl Oyster Fisheries of the Gulf of Manaar, 1903-1906," which contains an extensive faunistic survey of the seas around Ceylon, and brings to light interesting points with reference to the pearl oysters themselves.

With regard to the practical conclusions Professor Herdman[1] attributed the intermittance of the fisheries in great measure to the following causes:—

1. The shifting of sand by currents and storms which overwhelms whole beds of oysters.

2. Second in importance, predatory organisms, notably large Rays, which feed upon the oysters, young and old.

3. Other factors, such as overcrowding, disease, and overfishing.

As the importance of the second of these factors has been greatly emphasised by subsequent work and has to some extent been treated in the Reports of the Company as a new discovery made since Professor Herdman published his report, it is well to note that Professor Herdman recognised the rôle of these organisms, even if he did not fully realise what a terrible scourge they were. Indeed, as a matter of fact, large rays had long been known as formidable enemies of the oysters, as reference to Sir William Twynam's Report to the Government, published in 1900, will at once show; and their importance was fully realised on some of the other pearl fisheries of the world long before Professor Herdman's visit to Ceylon. Professor Herdman's indictment of these predatory fishes was no doubt tempered by the view that they played a part in pearl causation, in that they harboured the adults of the worms which he believed to be the commonest cause of fine pearls. But if my view, set forth in detail in a paper about to be read before the Zoological Society, is correct, namely, that the theory that these worms are concerned in pearl production rests on quite insufficient evidence, and that the cestode theory enunciated by Professor Herdman will probably have to be abandoned and a fresh start made, then no clemency need be shown to these fishes. As a matter of fact I had already conceived and abandoned as untenable the cestode theory, after an examination of Dr. Kelaarts specimens of the Ceylon Pearl Oysters in the British Museum, before Professor Herdman went to Ceylon. It may well be

[1] Report on the Pearl Oyster Fisheries of the Gulf of Manaar, Part v, pp. 120-126.

that the cestode theory of pearl production has had much to do with the regrettable neglect of predatory fishes in the early stages of the Company's enterprise, just as it seems to have led to the framing of a Regulation actually protecting these pests, on the Mergui Pearl Fisheries ! [1]

Turning now to the definite recommendations made by Professor Herdman, with a view to combating the above adverse forces, if we eliminate those relating more to such matters as surveying and fishery methods, and also drift bottle experiments (the results of which appear to the present writer to be scarcely capable of economic application until the duration of the free swimming stage of the pearl oyster is more accurately known) there were two main recommendations, viz., transplantation (along with which we may include the thinning out of overcrowded beds) and cultching.

With regard to transplantation Professor Herdman spoke very definitely[2] as to its proved success on a small scale : "Transplanted specimens . . . flourished in our hands. Both at Galle and in the Gulf of Manaar (where some batches were moved from the Muttuvaratu Paar to the Cheval) the oysters improved in health and grew rapidly in size when moved to a new locality." [3] Professor Herdman considered that not only spat but oysters up to one year old could be transplanted, a view which is amply supported by experience elsewhere.

With respect to cultching, Professor Herdman recommended that areas of sandy bottom adjoining the more important Paars should have broken material, such as fragments of dead coral, lumps of rock and other rubble scattered over the bottom. He held that the whole of the plateau within the 10 fathom line was "potential Paar ground" and susceptible of artificial improvement.[1]

Such was the position when the Company was formed in March, 1906, and the pearl fisheries leased to it by the Government at an annual rent of Rs. 310,000. In addition to this rental the Company undertook under the terms of the lease to spend a sum of from Rs. 50,000 to Rs. 150,000 yearly (the amount to be apparently at the discretion of the Government) "on the experimental or practical culture of the pearl oyster and on the improvement of the pearl banks within

[1] Lower Burma. Rules under the Burma Fisheries Act, 1905, § 64 and § 67. Burma Fisheries Manual, Rangoon, 1909. These sections were cancelled in 1909.

[2] Report on the Pearl Oyster Fisheries, Part v, page 118.

[3] From part i of the Report, page 139, it would appear that the observations on the oysters, transferred from the Muttuvaratu Paar to the Cheval Paar on Mar. 14th, 1903, were only extended over a few weeks, namely, to April 19th.

[4] Report on the Pearl Oyster Fisheries, Part v, page 110.

the conceded area and the maintenance thereon of a proper breeding stock or otherwise in the improvement and development of the fishery."[1]

The minimum obligations of the Company were therefore about Rs. 360,000 per annum. In this connection it is interesting to note that the total revenue derived by the Government from the Fisheries during the 19th century, as given by Professor Herdman in a table compiled from the Government Records and published in his Report, pt. i, p. 4, amounts to Rs. 12,135,764, the minimum obligations to which the Company committed themselves (Rs. 360,000 per annum) therefore amounted to about three times the probable average annual revenue, while their maximum obligations (Rs. 460,000 per annum) amounted to nearly four times that amount. And even if we take the whole period 1801-1905, and include the proceeds of the three phenomenal fisheries of 1903, 1904, and 1905 (Rs. 816,478, Rs. 1,070,467, and Rs. 2,405,645 respectively) the Company was pledged to pay on the minimum scale more than twice and on the maximum scale about three times the probable average return. It would hardly be safe in view of the irregularity of the Fisheries to argue from shorter periods than these.

Even allowing that the methods of administering and carrying on the Fisheries were capable of improvement (and it is not altogether an easy matter to improve greatly on a system which has been carried on by able administrators and shrewd business men for thousands of years), and that the Company reckoned on increased returns by improving the methods of handling and disposing of the oysters, applied biology had a colossal task placed before it to make up this difference and in addition to pay dividends on a capital of £165,000.

At the time of the formation of the Company there were oysters ready for fishing on the banks, and these were in fact fished by the Government on behalf of the Company immediately on its formation, so that a handsome return was reaped almost before the Company had taken material shape, and a substantial dividend was paid within a few months of its incorporation. A second fishery was held a year after incorporation and another substantial dividend distributed. Indeed in the first two years of the Company's life upwards of £50,000 was paid in dividends on an issued capital of £90,000.

So rosy, in fact, were the prospects that no prospectus was issued to the public; I am informed by the Secretary that the original capital was all privately subscribed. The shares were only obtained by the

[1] Lease of the Ceylon Pearl Fisheries, Ceylon Sessional Papers, xl, 1907.

general public at a later date through the medium of the Stock Exchange, where they sold at a high premium. After the second dividend had been paid the pearl banks entered upon one of the characteristic barren periods, which at present shows no sign of terminating.

On the formation of the Company Professor Herdman was retained as scientific adviser, and his former assistant, Mr. Hornell, was made general manager, being succeeded in 1908 by Mr. Thomas Southwell, who received the title of scientific adviser. I understand that Professor Herdman still continues to act in a business capacity towards the Company.

I will now attempt to trace in outline, so far as it is recorded in the reports of the Company and in the scientific publications of its officials, what was done in the direction of scientific development (as apart from scientific research largely of a general faunistic kind) on the lines of Professor Herdman's two chief recommendations, transplanting and cultching.

With regard to transplanting, we have records of a couple of experiments, but I cannot find that there is any published evidence to satisfy biologists (or the Ceylon Government or shareholders) that transplanting, modified and aided by various devices, has been given a sufficient trial. Other molluscs, including several other species of pearl oysters, among them the Japanese pearl oyster, a close ally (or perhaps only a local race) of the Ceylon pearl oyster, have proved themselves capable of treatment in this way, and in at least two cases, Japan and the Gulf of California, pearl oysters are regularly transplanted with commercially successful results. There is no published evidence as to what the process of transplantation amounted to; for all evidence to the contrary it may have consisted in nothing more than dredging up oysters on one Paar and dumping them overboard on another. Two experiments appear to be recorded. Sir West Ridgeway said at the 1906 meeting of the company[1]:—"Remember that transplantation, the principal measure of development, is no mere theory. It has passed the experimental stage. Not very long ago Mr. Hornell transplanted in one lot, over 10,000,000 young oysters to safe ground, where, according to our latest accounts, they are doing admirably. These should be fishable two years hence." Nothing further was heard of these oysters. Neither the shareholders nor the scientific world appear to have been informed what became of them, whether they were eaten, or silted over or swept away, or whether they died from unknown causes. They

[1] Reported in the *Financial News* of Wednesday, 7th November, 1906.

certainly were not fished in 1908. Again, Mr. Southwell[1] states that in December, 1907, over 9,000,000 young oysters were transplanted from the Periya Paar to the Mid-west Cheval, but that they all died before May of the following year. Although on the next page Mr. Southwell suggests a possible partial cause of this loss, the question never seems to have been followed up. Professor Herdman has some of these dead young oysters in his collection at Liverpool.

With regard to the second matter, cultching, the terms of the lease required the Company to deposit annually not less than 500 tons of cultch on the pearl bank area under lease. Mr. Southwell[2] states that up to last year about 10,000 tons of broken bricks and tiles, a material that appears to decompose in five or six years, had been deposited. Mr. Southwell gives some ingenious figures to shows the futility of attempting to increase, to any appreciable extent, the area of Paar ground by cultching. Indeed the whole cultching enterprise, as carried on, seems almost ludicrous, something like attempting to cultch the bed of the ocean. The cultching policy appears to have been modified in 1909, but in the absence of spat-fall its success or otherwise could not be gauged.

Turning now from these two enterprises, which were the outcome of Professor Herdman's recommendations to the Government, it is interesting to note that the directors, on the advice of their scientific experts, put forward two further proposals which were expected to overcome the difficulties. The first proposal was made at the 1909 meeting,[3] and was the ingenious idea of protecting beds of spat, natural or transplanted, by horizontal wire netting. The general idea of netting (vertical rope nets were first thought of) had previously been put before the shareholders at the 1908 meeting,[4] and was stated to have received Professor Herdman's approval. The second proposal was the bold idea that the Company should breed their own spat in a tank.

I will deal with the latter first. This proposal is so remarkable that I quote Sir West Ridgeway's observations made at the 1909 meeting of the Company, as given in the official report of the proceedings in full. "He [*i.e.*, Mr. Southwell] emphasises the importance of protecting the broods at the outset of their life, by stating that a single oyster lays at the very least 1,000,000 eggs, out of which not more than three or four reach maturity. For about the first 9 days of life the microscopic oyster is a free-swimming animal,

[1] Ceylon Marine Biological Reports, Part v, March, 1911, p. 197.

[2] Ceylon Marine Biological Reports, Part v, page 195.

[3] This meeting is reported in the *Financial News* of Tuesday, 21st December, 1909.

[4] Reported in the *Financial News* of Saturday, 18th December, 1908.

settling at the bottom later. It is during this planktonic stage that this huge loss occurs, as they then form food to innumerable molluscs and crustacea. The 'spatfall,' as we know it, represents the very small percentage of young oysters which escape this destruction. From these premises Mr. Southwell draws the conclusion that if one oyster lays such a multitude of eggs, it would appear possible to obtain a very large spatfall, say 50,000,000 from 1,000 adult oysters during such times as would otherwise be blank years, and that the elimination of the ravages caused during this early stage would be necessary.

"As it would, of course, be impossible to deal with such spatfall in the open sea, Mr. Southwell has recommended the establishment of an oyster hatchery at Marichikadde, and we have already acted upon his advice. At a cost of only £20 a hatchery tank has been built on the foreshore at that place, where adult oysters will be isolated and the spatfall collected without danger to its existence from its enemies. The spatfall will later be transplanted to the open sea and protected by the netting already mentioned, and if the operations prove commercially successful they will be extended. It is however only proposed to adopt these methods during what would otherwise be lean years, and by these means, Mr. Southwell says, he has every reason to hope, from his experience and experiment, that totally 'blank' years will be obviated, and sufficient profit realised to contribute largely towards the fixed charges of the Company."

This is, biologically speaking, a most amazing proposal to lay before a body of shareholders as a business proposition. Large sums of money have been expended, and scientific work on a scale of complexity and involving minuteness of detail, which I think is probably beyond anything dreamed of in these Ceylon investigations, has been carried out in the hope of achieving this result; more especially in the United States, with reference to the American Oyster, *Ostrea virginiana*. Complicated apparatus has been designed and patented, many proposals have been put forward, but I think I am safe in saying that never, unless in a few laboratory experiments on a very small scale, has any marine mollusc been artifically nursed and carried through from the egg to the attached stage in a tank.[1] There would be considerable excuse for an officer like Mr. Southwell, cut off from access to literature, much of which is scattered in scarce technical journals, being unfamiliar (as would seem to be the case)

[1] The nearest approach to this was the breeding of the European oyster, *O. edulis*, in ponds with tidal supply, by Lacaize Duthiers, at Roscoff, in 1893. Comptes Rendus de l'Acad. des Sciences, 26th Sept, 1893.

with what has been tried elsewhere, though I venture to think that, the hope based on "experience and experiment" referred to by Sir West Ridgeway above, was most rash. But it would have been very desirable for the directors, in dealing with a highly technical point like this, to have obtained the opinion of an independent expert, as to whether there was a reasonable *a priori* ground for this hope. It is impossible to suppose that this proposal was referred to the Company's retained adviser in England, Professor Herdman.

There remains the proposal to protect the deposits of young oysters against their enemies by means of horizontal wire netting. This proposal, while open to certain theoretical objections, really furnished a distinct ray of hope to the shareholders. Moreover, Sir West Ridgeway informed the shareholders at the last annual meeting, and in a circular issued in May, 1911, that the Ceylon Government had expressed their willingness to consider proposals for a modification of the terms of the lease on reasonable evidence being adduced as to its practicability. Yet nothing appears to have been done. It seems strange that active measures were not taken to demonstrate this with transplanted spat or oysters, without waiting for a fortuitous spatfall. Pearl oysters were available in considerable quantity on an inshore area, so that Mr. Southwell was able in 1909 to get 35,000 oysters "from about 8 months to 2½ years old" for an experiment in the transmission of parasites from oysters to fish,[1] and again in 1910 12,000 oysters for a repetition of the same experiment.[2] And this inshore deposit is referred to in Mr. Southwell's last paper on the subject published in May, 1911.[3] The existence of these oysters was apparently unknown to the Chairman when he addressed the last annual general meeting.

But even if oysters of suitable age and condition could not have been obtained thus, it would have been worth while to go to the trouble of importing a few thousands of young spat from some other localities where they are procurable. Action such as this would have at least demonstrated to the Government that the Company were taking their scientific work seriously—which as things are they might reasonably be excused for doubting. In this connection it is only fair to the Directors to say that Professor Herdman appears to have advised them, after a special flying visit he paid to Ceylon in 1908, that he "was of the opinion that in the present condition of the Company's pearl banks, accurate navigation, careful and exhaustive inspection of the ground and wise administration are more important

[1] Ceylon Marine Biological Reports, Parts iv, p. 169.

[2] Ceylon Marine Biological Reports, Part v, March, 1911, p. 213.

[3] Spolia Zeylanica, vol. vii, Part xxvii, p. 124.

than the purely scientific side of the business." (Report of the 1908 meeting of the Company).

Mr. Southwell's writings betray a certain air of detachment from the side of the enterprise which alone matters to the investing public. Such detachment is not unnatural in the pure scientist. Thus in the Ceylon Marine Biological Reports, Part iv, May 1910, Introduction, p. 1, he says, "The difficulties in reference to the Ceylon pearl oyster are of a special character, but we have no reason to believe that with the extensive programme of work, both scientific and nautical, which the Company are carrying out, the main difficulties should not eventually be thoroughly mastered, and *successors be left to reap the benefit.*" The italics are mine.

And again, in Ceylon Marine Biological Reports, Part v, page 191, "As results of all this [scientific work] one would expect to find that periods of barrenness, which so often occur, have not that hall-mark of hopelessness they had years ago. The present situation, however, seems to indicate otherwise."

In fact Mr. Southwell's position practically amounts to a confession of failure, with somewhat vague hopes that at some remote date success will be achieved.

This brings me to what I regard as the real underlying causes of failure. These can be treated under two heads, scientific and administrative. With regard to the scientific causes I cannot help feeling that, throughout these Ceylon investigations, the weak point has been the failure to distinguish sufficiently sharply between those phenomena which have a special and intimate relation to that particular economic problem, the solution of which means so much to the Colony, viz., the acquisition of some control over the natural supply of pearl oysters and pearls, and those phenomena whose relations to the central problem are of a more general nature. I admit that these two groups of phenomena intergrade in a most distracting and elusive manner; and the choice of those questions which will be most likely to yield, to intensive study, facts of direct economic applicability, often requires a nice discretion. But it is probable that for special and intensive work such as is required if an old industry is to be suddenly revolutionised, the commercial value of the specialist employed will depend to a very great extent upon the soundness of his judgment in the choice of subjects on which to concentrate his energies. It may even be suspected that the too common opinion of business men as to the unpracticality of the economic biologist (which is reflected in the poor endowment of scientific research in England) is largely to be attributed to the failure of the biologist to realise this.

The exercise of this discretion requires some self-denial on the part of the specialist concerned, who has frequently to turn his back upon a line of enquiry pointing to theoretical conclusions of great novelty and attractiveness, in order to pursue another line which seems to indicate results that, while theoretically less interesting, may materially advance industrial interests.

Turning now from what I venture to consider has been the weakness of the work of the Company's scientific staff, it may be of interest to inquire into the attitude of the Directors who were responsible to the shareholders for the conduct of the business, towards scientific research. And here a biologist is faced with the difficulty that he cannot quite place himself in the position of the layman, with regard to the technicalities of his subject. Still, I think most biologists will agree that there are distinct evidences all through the published reports, and still more in the published biological works of the scientific staff, of an insufficiency of directive "business" control of the scientific side of the enterprise. The relatively small advance in our knowledge of the Pearl Oyster and Pearl production that can be recorded since Professor Herdman published his report is, I think, attributable in great measure to this. An active and vigorous constructive policy in this direction would seem specially desirable in the management of a Company formed largely to apply novel scientific methods to the improvement of an industry. With the great issues involved, was it sufficient to leave the initiative so largely in the hands of a busy professor in England, already fully occupied with other work, scientific and administrative, and a promising, but comparatively untried young man on the spot? I am sure Mr. Hornell and Mr. Southwell will recognise that I intend no slight when I say that the task which was imposed upon them was overwhelmingly too great for them, as indeed it would have been for almost any biologist. And when these gentlemen were appointed no sufficient effort seems to have been made to keep them to the main point—that of devising means for making the fisheries pay, which could probably only be done in one of two ways, rendering more constant the supply of oysters or augmenting the number and quality of pearls produced; which in their turn meant a really exhaustive and at the same time discriminating study of the oyster. Instead, Mr. Hornell seems to have been largely engaged in administrative work and in surveying, work which could probably have been done equally well by a man who was not a biologist, and Mr. Southwell's more strictly biological activities were in great measure dissipated over purely faunistic work, such as the description of new species of crabs and tape-worms, subjects which have at best a quite

indirect bearing on the main problems involved. A little intelligent directive advice, occasional consultation with outside experts, a policy which demanded more evidence of the probable utility of a piece of work before it was undertaken, might well have given this Company a quite different history. Let me say here that I do not think any scientific man who has seriously studied the pearl and mother of pearl fisheries question from the economic standpoint, could dare to hope that a company which started loaded with the heavy obligations which the Ceylon Company of Pearl Fishers accepted, could within a few years have been made into a paying concern by biological science. But I feel very strongly that such progress might have been shown that the Company could have satisfied the Ceylon Government that it would have been a good business deal for both sides to revise the terms of the lease, and to continue the partnership on terms less onerous than those imposed and accepted at a time when everybody concerned seems to have been filled with a fine optimism by the success of the phenomenal fisheries of 1903, 1904, and 1905, and the rich harvest which the immediate future promised and at once yielded: an optimism which has not been justified by subsequent events.

Royal Colonial Institute,
18th January, 1912.

REVIEWS.

Bigelow, M. A. and A. N.—Applied Biology, an elementary text-book and Laboratory guide. Pp. xi + 583, 166 figs. New York: The Macmillan Company, 1911.

Both of the authors of this work are well known as successful teachers of biology, and no small measure of their success lies in the fact that they have largely departed from the stereotyped lines of traditional biological teaching. They have attempted to select from the wide field of biological science the essential facts, and especially the great ideas of the science of life which are of interest to the average intelligent person.

The word "applied," as here used, does not refer to the limitations of economics, but rather the ideas of the science which apply to human life in its combined intellectual, aesthetic, economic, and hygienic outlook.

Much of the laboratory work is presented in the form of demonstrations, as, in the author's experience, such is ill adapted for individual study by students with limited time and training.

Taking the work as a whole it well fulfils the authors' purpose; there are certain features, however, which stand out as distinctly above the average of the general text-book; of these we would mention the chapters dealing with the comparison of animal and plant biology; life-histories of vertebrates; human structure and life-activities; and principles of biology applied to healthful living.

We would especially commend this book to teachers in secondary schools and colleges as being one full of suggestion and the outcome of long practical experience.

Darbyshire, A. D.—Breeding and the Mendelian Discovery. Pp. xii + 282, 4 cold. plts. and 35 illustrations. London: Cassell and Company, Ltd., 1911. Price .

It is seldom that an author fulfils the expectations aroused by the preface. The work before us is a striking exception. Mr. Darbyshire informs us that his book "is intended to serve merely as an introduction to the subject. My conception," he continues, "of the most serviceable form of such an introduction has not been to place before the reader a sketch which takes in the whole range of discovery and speculation in this sphere

of inquiry, but, rather, to open the door to an intimate familiarity with a few instances of the Mendelian phenomenon, and especially with those studied by Mendel himself."

We have now the fullest account in popular form of the seven pairs of characters studied by Mendel, all of which are excellently illustrated; indeed future writers on the subject might bear the method of illustration in mind. F equal this, and Ff equal the other, no doubt when juggled with sufficiently and well mixed up with other letters and signs, has, in some eyes, the appearance of being very learned and abstruse, but it is not the way to bring home to the lay mind or the student a lucid conception of the subject. We fully endose Mr. Darbyshire's words. "This remoteness of words from actuality is especially characteristic of much of the literature on the subject of heredity which has accumulated during recent years."

We would strongly recommend a careful perusal of chapter x. to all who purpose taking up the study of Mendelism; it is eminently practical, concise, and clear.

We doubt if there is any published work on this subject which will appeal to a wider circle than the beautifully-illustrated one before us. Indeed we venture to predict that for some considerable length of time to come it will be regarded as the standard introduction to Mendelism, a position which it justly deserves.

W. E. C.

Duggar, B. M.—Plant Physiology, with special reference to Plant Production. Pp. xv + 516, 144 figs. New York: The Macmillan Company, 1911.

The purpose of the author has been to produce a text-book on plant physiology that shall exhibit a considerable range of material, rather than a few topics exhaustively treated, that shall include both qualitative and quantitative work; and that shall keep in view, as far as possible, the relations of the science to plant production, drawing the illustrations, wherever convenient, from plants which are familiar and directly useful. Dr. Duggar has succeeded exceedingly well in keeping these three features to the fore, and has given us a text and reference book of great value to the student and general reader.

We cannot refrain from remarking upon the growing importance of the study of the activities and responses of organisms, notably to students of agriculture and medicine, and the work before us forms an excellent introduction for such.

The text has been carefully written, well illustrated by figures, and appended to each chapter is a section dealing with laboratory work, and references to the more important literature and text-books which considerably enhance the value of the subjects treated of.

The work will well repay a careful perusal, and, judging from the lucid and interesting manner in which it is written, there is little doubt of its not receiving it.

Fream, W.—Elements of Agriculture. 8th Edition. Edited by J. R. Ainsworth-Davis. Pp. xiv + 692, 18 plts. and 270 figs. London: John Murray, 1911. Price 5s. net.

It was no light task that Professor Ainsworth-Davis faced when he undertook the editing of a new edition of this well-known manual.

The fact that it had previously run through seven editions embracing 39,000 copies speaks for itself as to the value of the work.

The new edition departs very little from the old one, the revisions, additions, corrections, etc., have been most carefully made, whilst the plates of representative animals distinctly add to the value of the book.

For many years it has enjoyed the distinction of being the most complete compendium upon its subject, and the present edition can only enhance its reputation. It will appeal to a new generation of students of agriculture with all the interest that Dr. Fream's first edition did to one that is now past.

All interested in agricultural education are indebted to the Royal Agricultural Society, the editor, and his assistants for the work they have so successfully accomplished.

French, C.—A Handbook of the Destructive Insects of Victoria. Pt. V, pp. 169, 39 plts., and 4 text figs. Melbourne: J. Kemp, 1911. Price 2s. 6d.

We welcome a fifth part of Mr. French's *Destructive Insects of Victoria*, which follows the plan laid down in previous parts.

As in part 4, the one before us deals with a number of insects attacking forests, amongst which we may mention *Diadoxus scalaris*, L. & G., *D. erythrurus*, White, *Frenchia casuarinae*, Maskell, *Uracanthus strigosus*, *U. bivittata*, *U. simulans*, *Phoracantha tricuspis*, *P. recurva*, *Platypus cupulatus*, Chp., *Distichocera macleayi*, Newman, *Aesiotes notabilis*, Pascoe, *Stigmodera heros*, Gehin., and many others. In addition to these, numerous pests of the Tomato, Sweet-potato, Vine, Fig, etc., are described.

All the species described are illustrated by excellent coloured figures, which cannot fail to prove of great value to foresters, fruit-growers, and others, for whom this work is written.

As in previous parts a number of insect-destroying birds are described and figured.

We look forward to part 6 of this work, which will complete it, and thus gives to the growers of Victoria a standard work on Economic Entomology and Ornithology.

W. E. C.

Howard, L. O., and W. F. Fiske.—The Importation into the United States of the Parasites of the Gipsy Moth and the Brown-tail Moth: a Report of Progress, with some Consideration of Previous and Concurrent Efforts of this kind. Pp. 312, 28 plts. and 74 text figs. Washington: U.S. Dept. Agric., Bur. of Entom., Bull. No. 91, 1911.

In the efforts that have been made to make the parasitism of insect pests a factor in the control of injurious species, the economic entomologists of the United States have during the past half century taken a leading part. Many failures attended the early efforts; indeed it was not until 1889 that any success was obtained, when the late Professor Riley imported a coccinellid beetle, *Novius cardinalis*, Muls., from Australia into California, to attack the fluted cushion scale (*Icerya purchasi*, Mask.), which threatened the extinction of the orange and lemon groves of California. The results are now well known, and this scale pest is no longer a factor in Californian horticulture. Since then numerous other insect parasites have been introduced, some of which have met with measurable success, and others with very positive results. Throughout this work, which has at the same time been going on in many other countries, the presiding genius in the United States has been the author of the report before us, the Chief of the U.S. Bureau of Entomology.

Dr. Howard has set forth the history of the subject in a full and lucid manner, recounting the early ideas that prevailed on introducing insect parasites to control the ravages and spread of the Gipsy and Brown-tail moths. The narrative of the progress of the work is set forth in great detail, and a list of the known and recorded parasites scheduled.

The establishment and method of dispersion of the newly-introduced parasites, the probable effect which the prevalence of disease would possibly have upon the pests, parasitism as a factor in insect control, the extent to which the Gipsy Moth is controlled through parasitism abroad, and numerous other subjects are dealt with at length.

Dr. Howard concludes that "It can be said with the utmost assurance that if a sufficient number and variety of parasites and other natural enemies of the Gipsy Moth . . . can be introduced into America, the automatic control will be permanently effected."

The Report is fully illustrated and worthy of the traditions of the Bureau over which the distinguished author of this Report presides.

W. E. C.

Johnstone, James.—Life in the Sea. Pp. vii + 150, illustrated. Cambridge University Press, 1911. Price 1s. net.

The author of this little volume is well known as an authority upon Fisheries, indeed he is primarily responsible for the position that the

University of Liverpool has attained in such matters; it would therefore have been difficult to find a worker more competent for the writing of this most interesting volume.

He has very wisely refrained from overburdening his subject. After a brief outline of the categories of life in the sea, we have a delightful account of the rhythemical change in the sea, followed by discourses on the factors of distribution, the modes of nutrition and sources of food.

The book is one calculated to stimulate the appetite and make the reader wish for more It is certainly one of the best of this series of Cambridge Manuals.

W. E. C.

Looss, A.—The Anatomy and Life-History of *Agchylostoma duodenale*, Dub. Pt. II. Rec. Egypt Gov. Sch. Med. Cairo, 1911, pp. 163-613, plts. xi-xix.

It is six years since part i of this magnificent monograph appeared, and in welcoming the second and concluding one we must congratulate Professor Looss on the completion of such a thorough and exhaustive treatise; indeed he has left little to be desired in the fulness of its material. So great is this, that it is not possible here to give more than a summary of the chief contents.

After a brief introduction the author opens with a general account on the comparative anatomy, classification and development of nematodes, with special consideration of those points which have led earlier authors into error. This is followed by a detailed account of the development, in which the egg, its shell, contents, and stage at which the eggs are laid, are dealt with, also the eggs of other nematodes, which have been, or might be mistaken for the eggs of the species treated of. The consideration of fertilized and unfertilized eggs, the embryonic development, the hatching of the embryos, and the larva, form a second section, and separate sections are devoted to the consideration of the conditions necessary for the development of the eggs and larvae; details from the biology of the mature larvae; modes of infection; some details from the migration of the larvae; the symptoms produced by the migration of the larvae in man; and the comparative frequency and practical significance of the two modes of infection, *i.e.*, oral and dermal.

There is copious bibliography with list of authors' names quoted, and a list of the genera and species referred to in the text, together with full explanations of the reference letters and figures, of which latter there are upwards of two hundred and fifty.

The author has earned the gratitude of all future workers in this field for a monograph of more than usual merit.

Massee, George.—British Fungi, with a chapter on Lichens. Pp. vi + 551, 40 cold. and 2 pl. plts. and 19 text figs. London: George Routledge and Sons, Ltd. (1911). Price 7s. 6d. net.

Mycologists who desire a condensed and illustrated account of the British Fungi will welcome Mr. Massee's work. As the author states, the primary object of his book is to enable the reader to determine the names of our indigenous fungi, and the forty admirably coloured plates cannot fail but prove a great help towards this end.

The general introduction and the chapters on the terminology, classification, when and where to collect fungi, the collecting and preserving of fungi, the ecology of fungi, edible and poisonous fungi, and diseases caused by fungi, are all written in Mr. Massee's well-known style.

The book will form an excellent introduction for those who desire to know more than a mere string of names.

An interesting chapter on Lichens and a very complete index completes a very handy and beautifully illustrated manual.

Warming, E.—Plant-Life. Trans. by Metta M. Rehling and Elizabeth M. Thomas. Pp. viii + 244, 249 figs. London: George Allen and Co., Ltd., 1911. Price 4s. 6d. net.

The sub-title of this little work—"a text-book of Botany for schools and colleges"—but ill expresses the contents; we should certainly prefer that of "outdoor" botany.

The novel method of treatment, the directness of style, the simplicity of view and the wealth of illustrations, will certainly recommend the book to a wide circle of students who have wearied of the modern elementary botanical text-books.

The work is well printed, excellently illustrated, and there is a good index.

Webster's Forester's Pocket Diary (10th ed.) **for 1912.** Pp. 94-192. London: William Rider and Son, Ltd. Price 2s. 6d. net.

This well-known publication fully maintains the high standard set in previous issues. To foresters, estate agents, nurserymen and others, it must prove a most useful and valuable diary. There is a wealth of information on almost every subject concerned with forestry, and the information given is concise and correct, whilst a very complete list of contents further enhances its value.

CURRENT LITERATURE.

I.—General Subject.

Anon.—Entomology in the West Indies. W.I. Bull., 1911, vol. 11, pp. 282-317.

Anon.—A Summary of Ten Years' Mycological Work of the Imperial Department of Agriculture for the West Indies. Ibid., pp. 318-350.

Bulletin of the Bureau of Economic and Social Intelligence. No. 8, pp. xvi + 269, No. 9, pp. 257, No. 10, pp. 223, Nos. 11-12, pp. 236. Rome: International Institute of Agriculture, 1911.

Bulletin of the Bureau of Agricultural Intelligence and of Plant Diseases. No. 7, pp. xvii + 1571-1844, No. 8, pp. 368. Rome: International Institute of Agriculture, 1911-12.

Wilson, James.—The Department of Agriculture in Relation to a National Law to Prevent the Importation of Insect-infested or Diseased Plants. U.S. Dept. Agric., Circ. No. 37, 1911, pp. 1-11

II.—Anatomy, Physiology, and Development.

Forbes, W. T. M.—A Structural Study of the Caterpillars, II. The *Sphingidae*. Ann. Entom. Soc. America, 1911, vol. 4, pp. 261-279. plts. 17, 18.

Grandori, R.—Contributo all 'embriologia e alla biologia dell '*Apanteles glomeratus* (L.), Reinh., imenottero parassita del bruco di *Pieris brassicae*, L. Redia, 1911, vol. 7, pp. 363-428, T. xiii-xvi.

Hilton, W. A.—The Structure of the Central Nervous System of *Corydalis* larva. Ann. Entom. Soc. America, 1911, vol. 4, pp. 219-256, plts. 15, 16, and 9 figs.

Hilton, W. A.—Structure of the Nerve Cells of an Insect. Journ. Comp. Neurol., 1911, vol. 21, pp. 373-378, 2 plts.

Hilton, W. A.—Some Remarks on the Motor and Sensory Tracts of Insects. Ibid., pp. 383-391, 2 plts.

Howard, A. B.—The Light Organ of Fire-flies. Ann. Trans. Mus., 1911, vol. 3, pp. 58-62, 4 plts.

Janet, Charles.—Sur l'existence d'un organe chordotonal et d'une vésicule pulsatile antennaires chez l'Abeille et sur la morphologie de la tête de cette espèce. Compt. rendus, 1911, T. 152, pp. 1-3, 1 fig.

Janet, Charles.—Constitution morphologique de la bouche de l'insecte. Fasc. 29, 35 pp., 2 plts. and 2 figs. Limoges, 1911.

Montgomery, Th. H.—The Spermatogenesis of an Hemipteron, *Euschistus*. Journ. Morph., 1911, vol. 22, pp. 731-798, 5 plts.

Ramme, W.—Die Bedeutung des Proventriculus bei Coleopteren und Orthopteren. Zool. Anz., 1911, Bd. 38, pp. 333-338.

Teodoro, G.—La secrezione della cera nei maschi della *Pulvinaria camelicola*, Sign. Redia, 1911, vol. 7, pp. 352-362, 4 figs.

III.—General and Systematic Biology, and Geographical Distribution.

Bacot, A.—On the Presence of Bacilli in the Gut of an Insect during Metamorphosis. Trans. Entom. Soc. Lond., 1911, pp. 497-500.

Bagnall, R. S.—A Synopsis of the British Symphyla with Descriptions of New Species. Trans. N. H. Soc. Northumb., 1911, n.s. vol. 4, pp. 17-41, plt. i, and 4 text figs.

The value of this interesting paper would have been considerably enhanced by complete figures of the new species.

Banks, Nathan.—The Pseudoscorpions of California. Pomona Coll. Journ. Entom., 1911, vol. 3, pp. 633-640, 1 fig.

Barber, T. C.—The *Coccidae* of Lousiana. Journ. Econ. Entom., 1911, vol. 4, pp. 448-451.

Berlese, A.—Acarorum species novae quindecim. Redia, 1911, vol. 7, pp. 429-435.

Berlese, A.—Come progredisce la *Prospaltella berlesei* in Italia. Ibid., pp. 436-461.

Burr, M.—Our British Dermaptera. Entom. Mon. Mag., 1911, pp. 225, 226, plt. 4.

Collins, J.—Notes on the early Stages of *Haemonia appendiculata*, Panz. Entom. Mon. Mag., 1911, vol. 22, pp. 248-250, 3 figs.

Cook, M. T.—The Relation of Parasitic Fungi to the Contents of the Cells of Host Plants (1. The Toxicity of Tannin). Delaware Coll. Agric. Exp. Stat., Bull. No. 91, 1911, pp. 1-77, 43 figs.

Crawford, D. L.—American *Psyllidae*. V. Pomona Coll. Journ. Entom., 1911, vol. 3, pp. 628-632, 1 fig.

Cushman, R. A.—Notes on the Host Plants and Parasites of some North American *Bruchidae*. Journ. Econ. Entom., 1911, vol. 4, pp. 489-510.

Davidson, W. M.—Two new Aphids from California. Journ. Econ. Entom., 1911, vol. 4, pp. 559-562, 9 figs.

Del Guercio, D.—Intorno ad alcuni Afidi della Penisola Iberica e di altre località, raccolti dal prof. I. S. Tavares. Redia, 1911, vol. 7, pp. 296-333, 30 figs.

Del Guercio, D.—Note Afidologische. Intono a due generi di Afididi americani. Ibid., pp. 462-464.

Depoli, G.—Ueber Skulpturabnormitäten bei *Carabus catenatus*, Panz. Zeit. f. wiss. Insektenbiol., 1911, Bd. 7, pp. 338-340.

Elliott, E. A., and Claude Morley.—On the Hymenopterous Parasites of Coleoptera. First Supplement. Trans. Entom. Soc. Lond., 1911, pp. 452-496.

Essig, E. O.—*Aphididae* of Southern California. VII. Pomona Coll. Journ. Entom., 1911, vol. 3, pp. 521-557, 17 figs.

Essig, E. O.—*Aphididae* of Southern California. VIII. Ibid., pp. 586-619, 16 figs.

Evans, W.—The Oligochaeta (Earthworms and their Allies) of the Forth Area. Proc. Roy. Phys. Soc. Edinb., 1910, vol. 18, pp. 109-124.

Felt, E. P.—Hosts and Galls of American Gall Midges. Journ. Econ. Entom., 1911, vol. 4, pp. 451-475.

Felt, E. P.—New Species of Gall Midges. Ibid., pp. 476-484, 1 fig. i.

Felt, E. P.—New Species of Gall Midges. Ibid., pp. 546-559.

Foster, N. H.—On Two Exotic Species of Woodlice found in Ireland. Irish Nat., 1911, vol. xx, pp. 154-156.

Gahan, A. B.—Notes on Two Important Parasites of Economic Insects. Journ. Econ. Entom., 1911, vol. 4, pp. 423-425.

Gahan, A. B.—A Note on *Xylocrabro stirpicola*, Pack. Ibid., p. 431.

Girault, A. A.—Hosts of Insect Egg-Parasites in North and South America. II. Psyche, 1911, vol. 18, pp. 146-153.

Griffini, A.—Grillacridi e Stenopelmatidi raccolti nella Nuova Guinea dal prof. L. Schultz. Redia, 1911, vol. 7, pp. 334-351, 1 fig.

Grossenbacher, J. G., and B. M. Duggar.—A Contribution to the Life-history, Parasitism and Biology of *Botrysphaeria ribis*. New York Agric. Exp. Stat., Tech. Bull. No. 18, 1911, pp. 113-190, 12 figs.

Hall, H. V. M.—Studies in Acarina. II. Pomona Coll. Journ. Entom., 1911, vol. 3, pp. 641-648, 6 figs.

Hewitt, C. G.—On *Coelopisthia nematicida*. Pack., a Chalcid Parasite of *Lygaeonematus erichsonii*, Hartig. Canad. Entom., 1911, vol. 43, pp. 297-303, 4 figs.

Hunter, W. D., and F. C. Bishopp.—Some of the more important Ticks of the United States. Year-book U.S. Dept. Agric. for 1910, 1911, pp. 219-230, plts. xv, xvi.

Hutton, A.—On the Morphology of *Oxyuris ambiguus*, Rud. : Type of the Genus *Passalurus*. Journ. Lond. Sch. Trop. Med., 1911, vol. 1, pp. 11, 12.

Keilin, D.—On the Parasitism of the Larvae of *Pollenia rudis*, Fab. in *Allolobophora chlorotica*, Savigny. Proc. Entom. Soc. Wash., 1911, vol. 13, pp. 182-184.

Mitterberger, K.—Zur Biologie von *Depressaria heydenii*, Z. Zeit. f. wiss. Insektenbiol., 1911, Bd. vii, pp. 285-287.

Newstead, R.—The Papataci Flies (*Phlebotomus*) of the Maltese Islands. Ann. Trop. Med. and Paras., 1911, vol. v, pp. 139-186, plts. v-vii, and 19 figs.

Newstead, R., and H. F. Carter.—On some New Species of African Mosquitos (*Culicidae*). Ibid., pp. 233-244, plt. xi.

Paoli, G.—Nuovi Labsulbeniomiceti parassite di Acari. Redia, 1911, vol. 7, pp. 283-295, T. xii.

Paris, G., ed A. Trotter.—Sui composti azotati nelle galle di *Neuroterus baccarum*. Marcellia, 1911, vol. 10, pp. 150-159.

Pierantoni, U.—Larven-Hermaphroditismus von *Icerya parchasi*. Zeit. f. wiss. Insektenbiol., 1911, Bd. vii, pp. 322, 323.

Reiff, W.—Experimente an überwinternden Lepidoptera-Puppen. Zeit. f. wiss. Insektenbiol., 1911, Bd. 7, pp. 343-347.

Rohwer, S. A.—New Sawflies in the Collection of the United States National Museum. Proc. U.S. Nat. Mus., 1911, vol. 41, pp. 377-411, 14 figs.

Shelford, R.—The British Museum Collection of *Blattidae* enclosed in Amber. Journ. Linn. Soc. (Zool.), 1911, vol. 32, pp. 59-69, plt. 7.

Stafford, B. E.—A New subterranean Freshwater Isopod. Pomona Coll. Journ. Entom., 1911, vol. iii, pp. 572-575, 2 figs.

Stichel, H.—Ueber Melanismus und Nigrismus bei Lepidopteren. Zeit. f. wiss. Insektenbiol, 1911, Bd. 7, pp. 341-343, 4 figs.

Stout, V. R.—A New Subterranean Freshwater Amphipod. Pomona Coll. Journ. Entom., 1911, vol. iii, pp. 569-571, 2 figs.

Townsend, Ch. H. T.—Review of Work by Pantel and Portchinski on Reproduction and Early Stage Characters of Muscoid Flies. Proc. Entom. Soc. Wash., 1911, vol. 13, pp. 151-170.

Verhoeff, K. W.—Über *Brachychaeteuma*, n.g. und *Titanosoma jurassicum* aus England. Zool. Anz., 1911, Bd. 38, pp. 455-458.

Viereck, H. L.—Descriptions of one New Genus and three New Species of Ichneumon Flies. Proc. U.S. Nat. Mus., 1911, vol. 41, pp. 293-295.

Wood, H. P.—Notes on the Life-history of the Tick Parasite, *Hunterellus hookeri*, Howard. Journ. Econ. Entom., 1911, vol. 4, pp. 425-431, plt. 19.

IV.—Agriculture and Horticulture.

Allard, H. A.—Some experimental Observations concerning the Behaviour of various Bees in their visits to Cotton Blossoms. Amer. Nat., 1911, vol. 45, pp. 607-622.

Barker, B. T. P., and C. T. Gimingham.—The Fungicidal Action of Bordeaux Mixtures. Journ. Agric. Sci., 1911, vol. 4, pp. 76-94.

Blake, M. A., and A. J. Farley.—Spraying Experiments with Peaches. N. J. Agric. Exp. Stat., Bull. No. 236, 1911, pp. 1-30, 12 figs.

Britton, W. E.—The Pyralid (*Omphalocera dentosa*, Grote), a pest of Barberry Hedges. Journ. Econ. Entom., 1911, vol. 4, pp. 521-524, plt. 20.

Brooks, F. T.—"Silver-leaf" Disease. Journ. Agric. Sci., 1911, vol. 4, pp. 133-144.

Buller, A. H. R., and C. W. Lowe.—Upon the Number of Micro-Organisms in the Air of Winnipeg. Trans. Roy. Soc. Canada, 1911, vol. iv, pp. 41-58, 3 figs. and 2 tables.

Carnes, E. K.—Investigations covering the "Mediterranean Fruit Fly" (*Ceratitis capitata*) in the Hawaiian Islands. Mon. Bull. State Comms. Hort., Sacr., Cal., 1911, vol. 1, pp. 5-13, 1 fig.

Chittenden, F. J.—Leaf Spot of Celery. Journ. R. Hort. Soc., 1911, vol. 37, pp. 115-122, 2 figs.

Chittenden, F. J.—A Note on the Habits of the Narcissus Fly. Ibid., pp. 122, 123.

Chittenden, F. H., and C. H. Popenoe.—Carbon tetrachlorid as a substitute for Carbon bisulphide in fumigation against Insects. U.S. Dept. Agric., Bur. of Entom., Bull. No. 96, pt. iv, 1911, pp. 53-57.

Coleman, G. A.—Methods of determining the Toxicity of Hydrocyanic Acid Gas. Journ. Econ. Entom., 1911, vol. 4, pp. 528-531, plts. 21, 22.

Cook, A. J.—The Alfalfa Leaf-Weevil (*Phytonomous murinus*, Fabr.), an alarming menace. Mon. Bull. State Comms. Hort., Sacr., Cal., 1911, vol. 1, pp. 19-22, 6 figs.

Cook, A. J.—Three Alarming Insect Pests. Pomona Coll. Journ. Entom., 1911, vol. iii, pp. 576, 577.

Cushman, R. A.—Studies in the Biology of the Boll Weevil in the Mississippi Delta region of Lousiana. Journ. Econ. Entom., 1911, vol. 4, pp. 432-448.

Essig, E. O.—Spraying for Black Scale on Deciduous Fruit and Olive Trees. Mon. Bull. State Comms. Hort., Sacr., Cal., 1911, vol. 1, pp. 15-17.

Essig, E. O.—The Potato Eelworm. Ibid., pp. 26-30, 2 figs.

Essig, E. O.—The Natural Enemies of the Citrus Mealy Bug. IV. Pomona Coll. Journ. Entom., 1911, vol. iii, pp. 518-522, 3 figs.

Evans, J. B. P.—South African Cereal Rusts, with Observations of the Problem of Breeding Rust-resistant Wheats. Journ. Agric. Sci., 1911, vol. 4, pp. 95-104.

Green, E. E.—The Rubber Slug (*Mariaella dussumieri*, Gray). Circ. and Agric. Journ. Roy. Bot. Gard. Ceylon, 1911, vol. 5, pp. 337-343, 1 plt.

Green, E. E.—Fruit and Pumpkin Flies. Trop. Agric., 1911, vol. 37, pp. 1, 2, 1 fig.

Goodey, T.—A Contribution to our Knowledge of the Protozoa of the Soil. Proc. Roy. Soc., B, 1911, vol. 84, pp. 165-180, plt. 4.

Hartzell, F. Z.—The Use of Sweetened Poisons against the Grape Root-Worm and the Rose Chafer. Journ. Econ. Entom., 1911, vol. 4, pp. 419-422.

Hinds, W. E.—Carbon bisulphide explosion from Heated Corn. Journ. Econ. Entom., 1911, vol. 4, pp. 532-535.

Horne, A. S.—On Tumour and Canker in Potato. Journ. R.H. Soc., 1911, vol. 37, pp. 363-389, 11 figs.

Kuwana, S. J.—The White-Flies of Japan. Pomona Coll. Journ. Entom., 1911, vol. 3, pp. 620-627, 2 figs.

Merrill, G. E.—The White Fly (*Aleyrodes citri*) in California. Mon. Bull. State Comms. Hort., Sacr., Cal., 1911, vol. 1, pp. 14, 15.

Metcalf, Z. P.—Test Sprayings for the Gloomy Scale (*Chrysomphalus tenebricosus*, Comst.). Journ. Econ. Entom., 1911, vol. 4, pp. 515-521.

Morgan, A. C.—Insect Enemies of Tobacco in the United States. Yearbook Dept. Agric., 1910, Sep. 537, 1911, pp. 281-296, plt. xx, 13 figs.

Moulton, D.—The California Peach Borer. U.S. Dept. Agric., Bur. of Entom., Bull. No. 97, pt. iv, 1911, pp. 65-89, plts. viii-x, 1 text fig.

Pantanelli, E.—L'Acariosi della Vite. Marcellia, 1911, vol. 10, pp. 133-150, 16 figs.

Popense, C. H.—The Indian Meal Moth and "Weevil-Cut" Peanuts. U.S. Dept. Agric., Bur. of Entom., Circ. No. 142, 1911, pp. 1-6, 1 fig.

Quayle, H. J.—Scale Insect Parasites in California. Journ. Econ. Entom., 1911, vol. 4, pp. 510-515.

Rorer, J. B.—Report of Mycologist for Year ending March 21, 1911. Pt. i. Circ. No. 2, Bd. Agric. Trinidad, 1911, pp. 1-13.

Sackett, W. G.—Hold-over Blight in the Pear. Colorado Agric. Expt. Stat., Bull. 177, 1911, pp. 2-8, 2 figs.

Sackett, W. G.—Bacteriological Studies of the Fixation of Nitrogen in Certain Colorado Soils. Ibid., Bull. 179, 1911, pp. 3-42, plts. i, ii, and 5 text figs.

Smith, J. B.—Insects Injurious to the Peach Trees in New Jersey. N.J. Agric. Exp. Stat., Bull. No. 235, 1911, pp. 1-43, 18 figs.

Urich, F. W., and P. L. Gappy.—Preliminary Notes on Some Insects affecting the Cocoanut Palm. Bd. Agric. Trinidad, Circ. No. 5, 1911, pp. 1-28, plts. i, ii.

V.—Forestry.

Parker, W. B.—California Redwood attacked by *Termes lucifugus*, Rossi. Journ. Econ. Entom., 1911, vol. 4, pp. 422, 423.

Stebbing, E. P.—The Blue Pine *Tomicus* Bark-Borer. For. Bull. No. 5, 1911, pp. 1-7, 3 figs.

VI.—Fisheries.

VII.—Medicine.

Alcock, A.—Some Recent Publications relating to Medical Entomology. Journ. Lond. Sch. Trop. Med., 1911, vol. 1, pp. 3-7.

Hindle, E.—The Relapsing Fever of Tropical Africa. A Review. Parasitology, 1911, vol. 4, pp. 183-203.

Howard, L. O.—House Flies. U.S. Dept. Agric., Farmers' Bull. 459, 1911, pp. 1-16, 9 figs.

Minett, E. P.—The Question of Flies as Leprosy Carriers. Journ. Lond. Sch. Trop. Med., 1911, vol. 1, pp. 31-35.

Smith, R. I.—Formalin for Poisoning House Flies proves very attractive when used with sweet milk. Journ. Econ. Entom., 1911, vol. 4, pp. 417-419.

VIII.—Animal Diseases, etc.

Dawson, C. F.—Anthrax. Delaware Coll. Agric. Exp. Stat., Bull. No. 90, 1910, pp. 1-61.

Fantham, H. B., and A. Porter.—On a Bee-Disease due to a protozoal Parasite (*Nosema apis*). Proc. Zool. Soc., 1911, pp. 625, 626.

Leiper, R. T.—Notes of Recent and some New Records of Helminthes in Man of which there are few records. Journ. Lond. Sch. Trop. Med., 1911, vol. 1, pp. 16-19.

Leiper, R. T.—Check-List of Helminthes Parasitic in Equines. Ibid., pp. 22-26.

Leiper, R. T.—A new Echinostome Parasite in Man. Ibid., pp. 27, 28.

Leiper, R. T.—A Method for dealing with Town Wells infected with Guinea-worm. Ibid., pp. 28-30.

Leiper, R. T., and M. T. Maher.—Check-List of New Genera and Species of Helminthes in 1911. Journ. Lond. Sch. Trop. Med., 1911, vol. 1, p. 13.

Shipley, A. E.—The Diseases of Hive Bees. Pp. 8, 6 figs. London: Offices of "Country Life," 1911. Price 6d.

Shipley, A. E.—Strongylosis in the Sheep. Pp. 7, 7 figs. London: Offices of "Country Life," 1911. Price 6d.

THE

JOURNAL OF ECONOMIC BIOLOGY.

BIOLOGICAL TRAINING FOR AGRICULTURAL STUDENTS.*

By

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At two previous meetings this Association has discussed the subject of educational courses in what may be called applied biology. Our gathering at Manchester in 1910 was noteworthy in eliciting from Professor S. J. Hickson a valuable paper "On the Place of Economic Zoology in a Modern University,"[1] while last year, at Birmingham, Mr. H. Maxwell-Lefroy,[2] viewing the question from a standpoint quite different, gave his weighty opinions on "The Training of an Economic Entomologist." Professor Hickson approached economic zoology as a subject to which the attention of biological students in a great modern university might be profitably directed, and discussed the kind of treatment that might be expected to fit such students for careers in practical and applied science. Mr. Maxwell-Lefroy, on the other hand, insinuating a gentle complaint at the too "academic" character of the Professor's survey, spoke as a busy worker in a great tropical country, to whom the practical extermination of insect pests is the main object in life, and to whom the training in a British University seemed but ill adapted to fit men for fulfilling this object.

In welcoming most heartily the members of this Association to the Royal College of Science for Ireland, it may be appropriate for me to give a brief account of the courses in biology that are given here for Associateship in the Faculty of Agriculture. It is not the aim of these courses to train specialists in economic zoology or in any of its branches. The majority of our agricultural students become instructors in the various Irish counties, or teachers in

* Read before the Association of Economic Biologists, Dublin Meeting, March 28th, 1912.

[1] Journ. Econ. Biol., vol. v, 1910, pp. 79-87.

[2] *Ibid.*, vol. vi, 1911, pp. 50-58.

winter schools, or are employed on the staff of one of the Agricultural Colleges or Stations, in connection with the Department of Agriculture's general scheme of rural education in Ireland. Several are now Inspectors or hold other official posts in the Department. As time goes on, it is hoped that an increasing proportion of students from this College will apply their scientific knowledge directly to practical agriculture on their own farms. But in any case, the application of science to local rural industry is the problem which our graduates have to face, and in their various spheres of work they find this an exacting task. Yet we believe that the training received in this College prepares a man to fit himself for any special line of biological investigation which may present itself to him, and which he may have leisure and opportunity to follow up.

It may be well to mention that practical farm-work is not taught in connection with the Agricultural Faculty of this College. A competent knowledge of farm practice is rigidly required as part of the entrance qualification, but the courses of instruction are in the sciences that bear on agriculture, with an extended series of lectures from the Professor of Agriculture in the closing year. The course for the associateship diploma, hitherto completed in three years, has lately been extended to four. This lengthening will prove a great advantage, as the time gained will be only to a small extent occupied by fresh subjects; most of it will be utilised in allowing a more leisurely and detailed survey of the main subjects of the curriculum than was possible under the old three-year scheme.

No biological subject is taken in the first year, which is devoted to mathematics, mechanics (now taught by experiment as well as by calculation) physics, chemistry, and drawing. These courses prepare the way for the second year, in which the interest is mainly biological, botany occupying most of the first, zoology of the second, and geology of the third term. The time not devoted to these natural sciences is occupied with a chemical course, largely organic. In these second year zoological and botanical classes the agricultural students pursue a general course, together with others who take natural science subjects. Of this general course in zoology, it need only be said that physiology and classification are more fully discussed than is usual in elementary university courses, and that in the systematic survey of animals general principles are regarded as more important than minute details about special types.

In the third year, besides attending lectures on agriculture and veterinary hygiene, and classes in surveying and engineering, the students take their applied work in zoology (first term), geology (second term), and botany (third term). That is to say the third

year classes in these subjects are conducted specially from the agricultural standpoint. In the zoological course are comprised (*a*) animal physiology, (*b*) a set of lectures on heredity and the factors of evolution, and (*c*) a systematic course dealing only with those groups—such as the Protozoa, Parasitic Worms, Insects, Birds and Mammals—which have a direct connection with agriculture. The course in agricultural botany includes practical plant physiology, plant diseases due to fungi, the identification of economically important plants such as grasses, and of seeds; also the practice of seed testing and the study of weeds and their life-relations.

In the fourth year agriculture and agricultural chemistry are studied; and there is one biological subject of great importance—agricultural bacteriology. Besides receiving training in the general biology of micro-organisms, and in practical cultural methods, the students examine bacteriologically air and water, soils and manures, milk, butter and cheese.

Such then are, in brief outline, the biological courses provided for agricultural students. Besides the strictly agricultural students, there are usually in the College a few men pursuing courses in horticulture, forestry, or creamery management. For these special modifications of the courses are necessary, but in most of the biological subjects all students of the faculty of agriculture work together. We believe that these courses afford a good foundation on which our men in their post-graduate days can raise a structure of useful application and research.

It remains to add a few words as to the methods of conducting these classes. The supreme importance of practical observational and experimental work in science has been a ruling principle of this College from its foundation in 1867. Laboratory practice is in all cases the ground-work of the course, and in the zoological classes I have followed the plan of first taking the dissection of an animal in the laboratory and then discussing its relationships in the lecture-room. We have also been led to attach much importance to field work. Usually one day a week through six months of the College session is spent by our natural science students out of doors. The direction of the day's work may be shared by botanical and zoological teachers, or by geological and botanical, or by zoological and geological, or by all three. Such variety may lead to a certain amount of discursiveness, but it impresses the students with the unity of natural phenomena, and brings home the importance of environment in relation to the organism. For those who have to apply biology to cultural and industrial problems, the field days seem to us simply invaluable and indispensable,

The question of the scientific training of men for any purpose may be regarded from the standpoint of the College or Institution that trains them, of the subjects which they have to study, of the practical uses to which they have to put their knowledge, or of the development of the men themselves. The last seems to me the most important of all, for if men be sent out with well balanced minds and well developed scientific interests, their Alma Mater must gain in reputation, they will add continually to their knowledge of the subjects which they have studied, and they will be able to apply such knowledge to the practical work of life. In biological or any other courses, the acquirement of knowledge is vain unless the student becomes possessed of a love for the subject and gains the desire and the power to learn more about it as opportunity may arise in later life. With regard to natural science, it seems especially necessary that those who are in any way guides to our rural population should be enthusiastically alive to the wealth of interest in the open countryside. The need for the spread of nature study is sadly shewn by the attitude of gaping wonder or of contemptuous amusement too often assumed by the "man in the field" to the out-of-door naturalist. The state of mind which induces this attitude, our rural instructors may do much to remove, and by removing it as well as by their more direct practical applications of biological science to agriculture they will take their part in checking that depopulation of our country districts which for years past has troubled our statesmen and social reformers. A mental revival in which natural science will have its due place is needed, as well as practical economic readjustments, in order to restore fulness and interest to rural life, and thus to stay the flow of the best blood of our land into the crowded cities of Great Britain and America. May the work of our men, touched with the greatness and mystery of the science of life, be of some power to stop the complaining cry that our people "go into captivity for lack of knowledge."

THE METHODS EMPLOYED IN TESTING GRASS SEEDS.*

By

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Economic Botanist and Director of the Seed Testing Station, Department of Agriculture and Technical Instruction for Ireland.

With 1 Figure.

In the year 1900 the English Board of Agriculture appointed a Departmental Committee to inquire into the conditions under which agricultural seeds were sold, and to report whether any further measures could with advantage be taken to secure the maintenance of adequate standards of purity and germinating power.

The report of this committee was published in 1901, and as a result of the inquiry it was recommended that a central seed testing station for the British Islands should be established. Although nothing appears to have been done in Great Britain to give effect to the Committee's recommendation, the Department of Agriculture and Technical Instruction for Ireland, recognising the importance of the matter, established a seed testing station for this country very soon after they came into existence as a Department of State. Their Station, which is at present located in the new buildings of the Royal College of Science in Dublin, is now in its twelfth year of existence, and has tested during this period over fifteen thousand samples of agricultural seeds, the average number tested for the past four years being over two thousand per annum.

The Station was established primarily for the benefit of farmers, and the fee to such for a complete test is but a nominal one, viz., threepence per sample. Irish seed merchants, however, have in some degree also availed themselves of the facilities offered by this Station and are doing so to an increasing extent, while the Station is also available to British and other seed merchants for the purpose of having seeds tested which it is proposed to supply to customers in Ireland.[1]

At a Seed Testing Station, as is well known, the seeds are in the main tested for two things, viz., purity and germination,

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* Read before the Association of Economic Biologists, Dublin Meeting, March 28th, 1912.

[1] Full details as to the regulations governing the use of this Station by the public will be found in Leaflet 59, Department of Agriculture and Technical Instruction for Ireland, which can be obtained free of charge on application to the Secretary.

[Journ. Econ. Biol., June, 1912, vol. vii, No. 2.]

the former being determined by weight and the latter by number. Doubtless the ideal way of testing seeds would be to test both for purity and germination by weight, but no practicable method of experimentally ascertaining the percentage of germination of seeds by weight has as yet been, or is likely to be, evolved.

The testing of many of the varieties of agricultural seeds for purity and germination presents no difficulties, but in the case of grass seeds there is some divergence of opinion amongst those engaged in seed testing as to what meaning is to be given to the term *purity* in the case of such seeds.

VIEW OF THE PRINCIPAL LABORATORY IN THE IRISH SEED TESTING STATION.

At the Irish Seed Testing Station the common-sense view is taken for all classes of seeds, that all the seeds in a sample which are or purport to be of the kind of which the sample is stated to consist are to be regarded as pure seed, the impurities consisting of foreign matter such as sand, dirt, and other such débris, as well as of the seeds of plants, whether noxious or otherwise, other than those of the particular kind specified in the designation of the sample.

This definition of purity is also accepted as a working basis at many continental and other stations for the majority of the kinds of seeds tested, even including those of some grasses, particularly the

smaller seeded ones, but at many of the stations an exception is made in the case of the larger and more important grass seeds such as those of the Rye Grasses, Cocksfoot, etc. It is a familiar fact that many of the seeds of grasses do not contain a kernel or caryopsis, or contain an imperfectly developed one only; in consequence of this at the continental and other stations mentioned an entirely different working definition is adopted for use in determining the purity of the seeds of the larger grasses to that adopted by these stations for the smaller grasses and for the other agricultural seeds.

At these stations not only are the real impurities, as defined above, treated as such, but so are also all those grass seeds in the sample under examination which do not possess, or appear not to possess a kernel or caryopsis, in spite of the fact that these seeds are of the kind named in the description of the sample, and that they would to the farmer certainly rank as seeds. It follows, therefore, that when this method is employed for carrying out a purity test the weight of the impurities in a given sample must be greater (and therefore the percentage of purity less) than when the same sample is analysed for purity according to what may, for brevity, be called the Irish method.

Since, however, the seeds necessary for carrying out the germination test are counted out, at all stations alike, from the seed after the impurities (however they may be defined) have been removed, it is evident that the percentage of germination will at the same time be affected. For when, as in what may be called the "Continental" method of purification, the real impurities in a sample have first been removed, and when to these the empty, or presumably empty, grass seeds have been added, there remains a quantity of *selected* seed, from which the requisite number of seeds for the germination tests are counted out. It stands to reason that the percentage of germination of such seeds must be higher, and in many cases will be considerably higher, than would be the case if the seeds for the germination test were taken after the real impurities only had been removed, the empty seeds being left in the sample. In short, certain kinds of grass seeds when tested by the continental method give higher percentages of germination and lower percentages of purity than they do when tested by the Irish method.

In the early days of seed testing on the continent the Irish method was in vogue there, but was discarded apparently because of the supposed difficulty of obtaining concordant results when two or more tests for germination were made from one and the same sample, or from successive samples from the same bulk. It would indeed

appear that of late years continental seed testing stations have devoted very close attention to the obtaining of as far as possible absolutely identical results in successive germination tests of one and the same or similar samples. It is, however, doubtful whether this should be the real aim of seed testing, for a certain amount of latitude between successive tests of the same sample must of necessity be allowed, and the most important aim of seed testing, namely, to give an adequate idea of the quality of the seed to the person who is going to sow it, must not be sacrificed in the endeavour to obtain absolute concordance in the results of successive tests.

A little consideration will show the way in which the method of carrying out the purity test affects the results of a test in practice. Thus to take an extreme case, consider a sample, say, of Meadow Foxtail seed which has been well cleaned and which therefore contains no real impurities such as dirt, foreign seeds, &c., but in which thirty per cent. of the seeds contain no caryopsis. Assume further that all the filled seeds germinate when placed under suitable conditions. Tested by the Irish method this sample would be returned as one hundred per cent. pure and as having a germination of seventy per cent. If tested by the continental method, however, the percentage of germination would be given as one hundred, while the percentage of purity would be less than this, say, ninety-five per cent. (the empty seeds are light), and if the farmer looked closely into the sample he might well wonder where the five per cent. of impurities was to be found!

It is not to be wondered at that some little confusion has arisen when the results of the tests of samples of seeds carried out by continental methods have been compared with those of the same seeds tested by the Irish method. The differences are of course most clearly evident in the percentages of germination, and as a rule the poorer the quality of the seed the more clearly will this fact be emphasised in the percentage of germination when the test is carried out by the Irish method. It certainly is to the percentage of germination rather than the percentage of purity that the farmer (and for that matter the seed merchant very often) looks for an indication of the value of his seed, and this being so it is not too much to say that when tested by the continental method, and when as is usually the case stress is chiefly laid on germination, seeds of second and third rate qualities may be made to appear to be a good deal better than they really are. Hence it is not altogether surprising that some vendors have been not a little disconcerted by the apparently low germination values given for their seeds when tested by the Irish method.

It is an unfortunate state of affairs that seed merchants and others should for so long a time have been bound to the coat-tails of continental countries in the matter of seed-testing, and we in Ireland are fortunate in having a Seed Testing Station of our own where the tests are carried out upon principles which can be relied upon to give accurate and fair ideas of the quality of all classes of seeds.

As has already been stated the Irish method of determining the purity of grass seeds is the older and common-sense one, and the following are some of the reasons why it was adopted at the outset and has not since been departed from.

1. In the case of grass seeds of the highest quality the proportion of empty seeds in the sample is small, and the Irish method of testing gives results which indicate the high quality of the seeds no less thoroughly than do those obtained by the continental method. As a matter of fact for seeds of the highest quality (which are what every farmer should seek to obtain and be prepared to pay a fair price for) very little difference will be found in the results of tests whether carried out by the Irish or by the Continental method. The following examples will illustrate this.

Results of tests showing that for the highest quality of grass seeds the Irish method gives figures which fully characterise them as such.

		Purity %	Germination %
Perennial Rye	(*a*)	99·9 ...	... 94
Ditto	(*b*)	99·9 ...	... 93
Italian Rye	(*a*)	100 ...	... 96
Ditto	(*b*)	100 ...	... 98
Meadow Fescue	(*a*)	98·9 ...	... 99
Ditto	(*b*)	99·5 ...	... 99
Cocksfoot	(*a*)	99·6 ...	... 95
Ditto	(*b*)	99·0 ...	... 94

Results of tests showing that for the highest quality of grass seeds there is but little variation in the results according as to whether the Irish or the Continental method is employed.

	Irish Method.		Continental Method.	
	Purity.	Germination.	Purity.	Germination.
Perennial Rye ...	98	92	99	93
Italian Rye ...	98	96	98	96
Crested Dogstail ...	99	95	98	95

(The results in these three cases of the tests by Continental methods were those supplied by the vendors of the seeds and were not obtained at the Irish Station.)

2. As previously mentioned more stress is apt to be laid, in general, upon the percentage of germination of a sample of seed than upon its percentage of purity. Indeed, requests are not infrequently made for reports upon germination alone, which, needless to say, are not and cannot be complied with, for it is impossible to test a sample for germination until the pure seed has first been obtained. It is therefore eminently desirable that the quality of the seed should make itself clearly evident and find its expression in the percentage of germination as well as in that of purity, and this is undoubtedly the case where the Irish method is adopted, but less so where the Continental method is employed. By the Irish method the actual seed, as supplied to the farmer, and as it will be sown by him, is tested for germination (only the real impurities having first been removed), whereas by the continental method (as explained previously) *selected* seed is employed for this test, and consequently the percentage of germination of a sample of second or even third class quality may be made to look comparatively high, and may, if germination mainly be taken into account, give quite an erroneous idea of the quality of the seed, as the following example will show:—

	Irish Method.		Continental Method.	
	Purity %	Germination %	Purity %	Germination %
Cocksfoot (1) ...	99·3	66	90·8	88
ditto (2) ...	98·0	51	87·5	69
Perennial Rye ...	90 6	60	86 7	75
Meadow Foxtail ...	95·3	52	89 0	62

When the percentage of germination of a sample of seed is multiplied by its percentage of purity a number is obtained which has been called the "true value" of the seed, and it might at first sight be supposed that the same true value would be obtained for a given sample by whichever of the two methods it was tested. This is, however, in general not the case, for although one per cent. of empty seeds by number will reduce the percentage of germination of a sample tested by the Irish method by one per cent., the percentage of purity will not be increased to a corresponding extent, owing to the lightness of the empty seeds and to the purity being determined by weight. A strong argument against the Continental method and in favour of the Irish method lies in the fact that it is quite impossible in many cases to decide *with sufficient accuracy* by mere examination of individual grass seeds (even with the help of the best optical appliances available) whether they contain kernels (caryopses) or not. This fact has recently been strikingly illustrated by Pieper.[1]

[1] H. Pieper, Vergleichende Keimversuche mit Grassamereien. Inaug. Diss. Jena (Ant. Kämpfe) 1909, p. 17.

Lots of four hundred seeds each of certain grasses were taken and soaked in water in order to make the separation of the empty from the filled seeds a more easy task, and lens as well as diaphanoscope were employed in the investigation. The same lots of four hundred seeds each were then submitted successively for separation into groups of empty and filled to four examinations by three different persons, and the following table shows the results obtained, with two of the kinds of seeds examined.

	Seeds examined by	Percentage of filled seed found.	
		Cocksfoot.	Golden Oat Grass.
1	A lady with ten years experience of seed testing	78	52
2	A gentleman, with some experience	52	62
3	A research-student in Seed Testing	55	40
4	Ditto, examined a second time ...	64	58

At the conclusion of the examinations the seeds were dissected and, with the aid of the microscope, the actual number of filled seeds was found to be in the case of Cocksfoot 69 per cent., and in that of Golden Oat Grass 38 per cent.!

From a consideration of results such as these the difficulty of accurately discriminating, as is attempted in the Continental method, between filled and empty seeds is at once apparent, and it is seen that the results must depend to a large extent upon the individuality or discretion of the person who carries out the test. Where the Irish method is adopted this important source of inaccuracy is avoided, and the personality of the tester entirely eliminated. As a matter of fact grass seeds are not naturally produced either strictly with or without a caryopsis, but all gradations are found passing from seeds which are well filled through those with smaller kernels until those with absolutely none are reached; and where a hard and fast line does not naturally exist it seems to be more or less futile to attempt to draw an artificial one.

4. As has been pointed out before the Irish method of determining purity must obviously be looked upon as the natural and common-sense one, and where it is employed the definition of purity is the same for all seeds, whereas the Continental method involves an alteration in the definition of purity according to the kind of seed under test, which, to say the least, is highly undesirable.

Formerly the Irish method was in vogue at Continental stations for all kinds of grass seeds, and apparently it is still employed at some of them. At the better known stations, however, it has been abandoned in favour of the selection method apparently because some difficulty was experienced in securing concordant results when two or more tests were made of the same sample or of similar samples from the same bulk.

Provided, however, that the samples are taken with the necessary care so as to represent fairly the bulk from which they are drawn, such difficulties are not really serious, and the following examples will show that concordant results (within the limits of reasonable variation) are obtained by the Irish method. It may be stated here that at the Irish Seed Testing Station never less than five hundred seeds are used for a germination test of grass seeds, and in some cases, such as Cocksfoot and Meadow Foxtail, at least nine hundred are taken.

(a) *Results of four successive germination tests of Cocksfoot seed, carried out on each of two samples during the course of several weeks, and showing the uniformity of the results.*

Sample A.	94 %	93 %	92 %	93 %
Sample B.	83 %	82 %	80 %	87 %

(b) *Results of similar successive germination tests carried out with a sample of Meadow Foxtail.*

Germination	39 %	36 %	31 %	35 %

(c) *Results of tests of three samples of Cocksfoot, taken by three different persons, from three different retail dealers, in three different Irish counties, on three different occasions, and tested at short intervals, it being discovered long after the tests were made that the samples represented different consignments from the same bulk from one wholesale vendor.*

	Purity.	Germination.
Sample A.	97·8 %	55 %
Sample B.	98·2 %	58 %
Sample C.	98·1 %	50 %

(d) *Results of tests of five samples taken by different persons at different times from different portions of the same bulk of Italian Rye Grass.*

Germination	85 %	91 %	89 %	85 %	87 %
Purity	99·9 %	99·6 %	99·7 %	99·6 %	99·8 %

When it is remembered that the latitude usually admitted to be allowable between the results of germination tests[1] of successive portions of a sample, even by the Continental method, is + 4.2 per cent. when the percentage of germination is between 95 and 100, and gradually rises to + 9.6 per cent. when it is between 50 and 55, it will be seen that the variations in the germination results given in the above examples are of no consequence, and it cannot therefore be admitted that concordant results are unattainable when the Irish method of determining purity is employed

Briefly summarised, therefore, it may be said that when this method is used great accuracy is possible, the personality of the tester is reduced to an absolute minimum, and the results give an extremely fair idea of the quality of the seeds under investigation, which is shown as much in the percentage of germination of the sample as in its percentage of purity, and for these reasons the method is much to be preferred to the one which prevails at most of the Continental stations.

There are reasons for supposing that the Continental authorities themselves are not altogether satisfied with the method adopted by them, at any rate Hiltner,[2] in a recent article, has ably discussed the whole matter, and advocates a return to the older definition of purity in connection with grass seeds, which has been the basis upon which all tests at the Irish Seed Testing Station have been conducted since its establishment about twelve years ago.

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[1] See "Technische Vorschriften für die Prüfung von Saatgut" in Landwirtschaftlichen Versuchs-Stationen, 1910. Bd. 72.

[2] Hiltner, Über die Bedeutung und die Bestimmung der Reinheit des Saatgutes. Praktische Blätter für Pflanzenbau und Pflanzenschutz, Dec., 1910. Bd. 8. Heft. 12, p. 137.

THE FOOD OF THE BULLFINCH, *PYRRHULA EUROPAEA*, VIEILLOT.

By

WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.

The purpose of this paper is to set forth in detail the results obtained from an inquiry as to the nature of the food of the Bullfinch during the different months of the year.

Considerable diversity of opinion exists both amongst fruit-growers and ornithologists as to whether this bird should be included amongst those that are injurious or beneficial, thus in a paper read before the Farmers' Club on April 3rd, 1905,[1] the Rev. H. H. Slater writes as follows: "The Bullfinch.—A perfectly harmless and altogether desirable neighbour, as it feeds on hedge fruits, seeds of dock, thistle, and other weeds, except in February and March, when it does serious damage, if not watched, to the gooseberry, plum and damson buds. It is never necessary, however, to shoot it—a little stone-throwing, or, better still, catapulting, is quite enough. Shooting at it injures the trees and bushes quite as much as the bullfinches do." That such an opinion is contrary to facts, I hope to prove in this paper.

Mr. Cecil H. Hooper[2] states: "The Bullfinch, which has been briefly described as not having one redeeming feature save his appearance, seems to be somewhat local, and is probably most plentiful near woods. When numerous in a fruit-growing district, it seems that for self-protection they must be killed, as the damage they do to the buds is a very serious matter, and often they wantonly destroy the buds without even eating them. They commence soon after Christmas, when the first spell of frost has sweetened the swollen buds, and continue eating them until the buds expand into leaves. The worst time is the beginning of March.

The bullfinch feeds on buds, especially of plants that bear fruit, such as plums, damsons, cherries, gooseberries, currants, apples, and pears; it shows a special liking for Greengage, Black Diamond, Purple Gage, and Early Rivers Plums, which it will first attack in an orchard. It shows a preference for certain varieties of gooseberries, and amongst apples the buds of 'Councellor' are favourites.

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[1] Wild Birds and the Farm. Journ. Farmers' Club, 1905, p. 247.

[2] Fruit Growing and Bird Protection. Journ. Soc. Arts, 1906, vol. lv, p. 77.

[Journ. Econ. Biol., June, 1912, vol. vii, No. 2.]

It also attacks the buds of hawthorn, blackthorn, bird-cherry, larch, and beech. Mr. F. Smith, of Loddington, says that bullfinches rove about, in families of five or six, through the winter. A family will come into a fruit tree, and stay there until they have destroyed all the buds, both fruit and wood; they usually begin with 'May Duke' cherries, in the early autumn, and keep on with plums, gooseberries, currants, and medlars; ending, in late spring, with black currants and apples. For six months they live almost entirely on fruit buds; on dissection, their crop may be found full of buds, while insects occur in very small numbers. The crops of bullfinches have been found full of gooseberry buds, even during the time gooseberries were coming into blossom."

This, the statement of a careful observer, presents the bullfinch in a rather different, but truer light.

Mr. C. F. Archibald[1] states: "Most unfortunately, this handsome finch destroys the buds of fruit trees and diminishes the yield to a serious extent. It takes very few insects."

Mr. Newstead,[2] in his work on the "Food of some British Birds," writes: "The serious nature of the havoc which this bird commits in destroying the buds of various fruit trees is so generally known that it would be superfluous to add to the already extensive literature on this subject."

Testimony from actual fruit-growers is interesting, and from a large number of letters I select the following statements:—

"Are a very serious pest in our orchards, without any redeeming feature save their appearance" (A. 327/11).

"The annual loss sustained by us must be upwards of £100 from these destructive birds" (A. 411/11).

"From December to the end of April these birds occasion a considerable amount of damage to our fruit-trees, and during the remainder of the year are active in distributing the seeds of various weeds. They should certainly be destroyed" (A. 429/11).

"Our plums (Greengage and Black Diamonds) have suffered terribly from these birds. In some cases the whole of the fruit-buds have been destroyed. We are sending ten birds shot to-day for examination" (A. 512/10).

I have made a *post-mortem* examination of 308 specimens, received from Worcestershire, Warwickshire, Staffordshire and Hereford, in addition to 176 examined in the months of April and May in 1907,-08,-09, and 10, making a total of 484.

[1] Notes on the Food of Wild Birds. Univ. of Leeds, Bull. No. 11, 1910, p. 7.
[2] Suppl. to the Journ. Bd. Agric., 1908, vol. xv, p. 45.

All the specimens were examined as soon as received, which seldom exceeded twelve hours after being shot, in many cases only four or five hours intervened between.

By far the larger number of fruit-growers, interviewed or written to, in the above-mentioned counties, agree that during the past six or seven years there has been a great increase in the number of these birds, and they would welcome any measures for aiding in considerably reducing their numbers.

Months.	Counties.				Total.
	Worcester.	Warwick.	Hereford.	Stafford.	
January	5	4	5	4	18
February	5	4	5	4	18
March	5	5	5	4	19
April	9	11	5	3	28
May	9	9	3	3	24
June	12	8	4	4	28
July	13	7	3	3	26
August	14	9	4	5	32
September	13	9	4	4	30
October	12	9	3	4	28
November	13	10	2	3	28
December	14	11	2	2	29
Totals ...	124	96	45	43	308

Nature of the Food.

January.—Eighteen birds were examined, of which eight were females and ten males. The food-contents were as follows:—

1-3.—Stomach contained remains of fruit buds of plum (?); seeds of sycamore (*Acer pseudo-platanus*); kernels of hawthorn and little grit.

4, 5.—Stomach almost empty, seeds of sycamore in gullet.

6, 7.—Fragments of fruit buds of plum; miscellaneous vegetable matter, consisting of fragments of seeds, etc.; little grit.

8.—Kernels of hawthorn and little grit.

9-11.— do. do.

12.—Miscellaneous vegetable matter; little grit.

13.—Fragments of fruit buds of plum.

14, 15.— do. do.

16-18.—Kernels of hawthorn; miscellaneous vegetable matter; little grit.

February.—Eighteen birds were examined, of which five were females and thirteen males. The food-contents were as follows:—

19-21.—Fruit buds of plum; fragments of seeds; little grit.

22, 23.—Kernels of hawthorns: fragments of (? plum) fruit buds.

24, 25.— do. do.

26-28.—Miscellaneous fragments of vegetable matter; little grit.

29-31.—Fragments of seeds.

32, 33.— do.

34, 35.—Fragments of fruit buds of currant; little grit.

36.— do. do.

March.—Nineteen birds were examined, of which eight were females and eleven males. The food-contents were as follows:—

37.—Filled with fruit buds (? plum).

38, 39.—Fragments of fruit buds of currants.

40-42.— do. do.

43-45.—Fragments of seeds and miscellaneous vegetable matter; little grit.

46, 47.— do. do.

48, 49.—Fruit buds of currants.

50-53.— do.

54, 55.—Fruit buds of gooseberry.

April.—Twenty-eight birds were examined, of which twelve were females and sixteen males. The food contents were as follows:—

56, 57.—Fruit buds of plum.

58.—Fruit buds of gooseberry.
59.— do. and little grit.
60-64.—Fruit buds of currants.
65-68.— do. and little fibrous vegetable matter.
69-72.—Fruit buds of plum.
73-75.—Fruit buds of currants.
76-80.— do. do.
81-83.— do. do.

May.—Twenty-four birds were received, fourteen were females and ten males. The food-contents were as follows:—

84, 85.—Filled with the remains of fruitlets of currants.
86-88.—Soft mushy vegetable matter (? plums).
89, 90.— do. do.
91-94.— do. do. and fragments of few seeds.
95.—Fragments of currants.
96.— do. do.
97.—Soft mushy vegetable matter (? plums).
98, 99.— do. do.
100-103.— do. do.
104.— do. do.
105-107.—Miscellaneous vegetable matter; remains of small Dipterous larva.

June.—Twenty-eight birds were examined, of which fifteen were females and thirteen males. The food-contents were as follows:—

108-113.—Miscellaneous vegetable matter.
114-117.—Fragments of seeds of weeds.
118-121.— do. do.
121-125.— do. do.
126-131.—Seven seeds of dandelion; little grit.
132-135.—Nine seeds of dandelion, 2 seeds (?).

July.—Twenty-six birds were received, of which twelve were females and fourteen males. The food-contents were as follows:—

136-148.—These were received throughout the month from Worcestershire. All were filled with fragments of leaf buds, 75 per cent.; bits of seeds, 10 per cent.; miscellaneous vegetable matter, 10 per cent.; and a little grit.

149-152.—Miscellaneous vegetable matter, probably leaf-buds; little grit.

153-155.— do. do.

156-158.— do. do.

159-161.— do. do. and seeds of elder (*Sambucus nigra*).

August.—Thirty-two birds were received, of which fourteen were females and eighteen males. The food-contents were as follows:—

162-165.—Blackberry seeds only.

166-168.—Seeds of selfheal (*Prunella vulgaris*).

169-172.—Few seeds of charlock (*Sinaspis arvensis*, Linn.); and seeds of blackberry (*Rubus fructicosus*, Linn.).

173-176.—Filled with seeds of elder.

177, 178.— do.

179-182.—About equal portions of seeds of blackberry and selfheal.

183-186.—Seventeen seeds of blackberry, 6 of elder, and 7 of selfheal.

187-191.—Few seeds of charlock.

192, 193.— do. do.

September.—Thirty birds were received, of which ten were females and twenty males. The food-contents were as follows:—

194-196.—Few seeds of groundsel (*Senecio vulgaris*, Linn.); little miscellaneous vegetable matter and little grit.

197-200.—Twenty-five seeds of selfheal and little grit.

201-203.—Filled with seeds of broad-leaved dock (*Rumex obtusifolius*, Linn.).

204-206.—Seeds of groundsel and ragwort (*Senecio jacobaea*, Linn.); little grit.

207-210.—Filled with seeds of mouse-ear hawkweed (*Hieracium pilosella*, Linn.).

211-214.—Few seeds of selfheal, nettle and chickweed (*Stellaria media*, Linn.).

215-217.—Eighteen seeds of sow thistle (*Sonchus oleraceus*, Linn.).

218-220.—Fragments of some soft seeds; 5 seeds of sow thistle and 8 of dock.

221-223.—Twelve seeds of selfheal; 9 of dock; and 18 of mouse-ear hawkweed.

October.—Twenty-eight birds were received, of which twelve were females and sixteen males. The food-contents were as follows:—

224, 225.—Full of seeds of dock.
226-228.—Few seeds of charlock and dock.
229-232.—Filled with seed of blackberry.
233-235.— do. do.
236-240.— do. do.
241-244.—Equal quantities of blackberry and dock seeds.
245-248.—Five seeds of nettle; 9 of dock; 23 of charlock.
249-251.—Few seeds of charlock and sow thistle; little grit.

November.—Twenty-eight birds were received, of which ten were females and eighteen males. The food-contents were as follows:—

252-257.—Seeds of dock and nettle; little grit.
258-260.— do. do.
261-263.— do. do.
264, 265.—Filled with seed of blackberry.
266-270.— do. do.
271-273.— do. do.
274-277.—Seven seeds of sow thistle; 3 of dock; little miscellaneous vegetable matter.
278, 279.—Few seeds of nettle and dock; little grit.

December.—Twenty-nine birds were received, of which eleven were females and eighteen males. The food-contents were as follows:—

280, 281.—Filled with seed of blackberry.
282-285.— do. do.
286-288.—Seeds of nettle and dock.
289-291.— do. do.
292-295.—Filled with seeds of curled dock (*Rumex crispus*, Linn.).
296-299.—Filled with fragments of leaf-buds.
300-303.—Kernels of hawthorn and fragments of fruit-buds.
304-308.—Fruit-buds of plum; a little miscellaneous vegetable matter, and a little grit.

Summary of Food.

Summarising the food-contents for the twelve months, we find the various items of food occurred as follows:—

Sycamore seeds	present	in	5 birds
Kernels of Hawthorn	,,	,,	18 ,,
Dandelion	,,	,,	10 ,,
Elder	,,	,,	13 ,,
Blackberry	,,	,,	48 ,,
Selfheal	,,	,,	22 ,,
Charlock	,,	,,	21 ,,
Groundsel	,,	,,	6 ,,
Broad-leaved Dock	,,	,,	46 ,,
Curled Dock	,,	,,	4 ,,
Mouse-ear Hawkweed	,,	,,	7 ,,
Ragwort	,,	,,	3 ,,
Nettle	,,	,,	29 ,,
Chickweed	,,	,,	4 ,
Sow Thistle	,,	,,	13 ,,
Fruit buds of plum	,,	,,	44 ,,
,, ,, currant	,,	,,	37 ,,
,, ,, gooseberry	,,	,,	4 ,,
Fragments of seeds (not identifiable)	,,	,,	35 ,,
Miscellaneous vegetable matter	,,	,,	52 ,,
Animal Food (Insects)	,,	,,	1 ,,

During the five months, January to May, the food consists largely of fruit-buds and fruitlets, and in addition to those which are actually eaten, an equal, or even larger, number are wantonly destroyed by this bird. I have watched it for hours on plum trees destroying the buds wholesale, and similarly on currants.

My year's record fully confirms the view I had previously held, largely founded upon observations in the field, that the bullfinch is for quite half the year most destructive in fruit orchards, causing considerable losses to growers, which far outweigh any little good it may do in keeping down the spread of weeds. Indeed, its value in this respect is extremely doubtful, for it certainly helps in the distribution of such weeds as the dandelion, dock, groundsel, ragwort, charlock, etc.

PRELIMINARY OBSERVATIONS ON THE MILDEW OF GREY CLOTH.

By

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With 3 Figures.

Cotton manufacturers and shippers are only too well aware that their goods are liable to become "mildewed" when in store or in transit. This may happen at any stage of manufacture from the yarn to the finished piece, or not infrequently while this last is on its way to a foreign destination. The appearances are various; usually, but not always, the cloth shows stains of a brown, grey, or even red or yellow colour. There is also a characteristic smell about the goods before any visible signs appear; in some cases the smell is not musty, but of a highly objectionable character. As some of the results obtained in an investigation of the "mildew" of prints, undertaken at the request of the Manchester section of the Society of Dyers and Colourists, seem of general interest, they have been brought together in this paper. The cotton goods here dealt with are chiefly grey cloths.

An attempt was made to determine what fungi caused the damage to the cloth. A starchy culture medium was prepared (potato agar), and plated into sterile petre dishes. Portions of affected cloth, about 5 mm. square, were finely shredded with sterile scissors over the surface of the medium, and the dishes were then incubated at a temperature of about 25° C. The results of some of the experiments may be briefly tabulated as below:—

No. of sample.	Kind of material.	Visible damage.	Organisms recognised.
I	Flour size	Fermenting.	Anaerobic bacteria (2 spp ?).
II	Grey cloth	None. Bad smell when case opened.	Bacteria only

No. of sample.	Kind of material.	Visible damage.	Organisms recognised.
III	Grey cloth	Blackish streak, 10″ along fold. Black, yellow and pink spots.	*Penicillium glaucum*, *Mucor* spp. (*M. racemosus* and *spinosus*.) *Fusarium* sp., few bacteria.
V	Grey cloth	Numerous black, also crimson and yellow spots.	*Fusarium* sp., little *Mucor* & *Penicillium*, few bacteria.
VIII	Coarse cloth Much size	Brown stains.	*Penicillium glaucum*, *Aspergillus* sp., *Torula* sp., few bacteria.
XI	Velveteen	Many black, also crimson spots.	*Chaetomium murorum*, *Stysanus* sp., *Fusarium* (little).
XII	Khaki cloth	Lighter spots.	Bacteria only.
XIII	Cops	Outer threads discoloured.	*Fusarium* sp., also *Penicillium glaucum*, few bacteria. Fig. 1.

Two things are apparent from the above table. The first is that in some cases fungi proper are not the cause of the defect known as "mildew." In the case of both the flour size (No. I) and the khaki cloth (No. XIII) only bacteria were found. The size showed at least two species which were anaerobic, and probably the fermentation may be attributed to their action. Since the optimum temperature for bacterial growth is higher than that of most fungi, much of the damage done to cloth in tropic waters might be due to bacteria. The point, however, requires further investigation.

The second point is that a large number of species of fungi were recognized, all of them common saprophytes, with one exception (*Chaetomium*), especially on starchy matter. This is not surprising, when we consider the food available. Cotton goods contain, in addition to the cellulose of the fibre, a varying quantity of size. In the cheaper kinds of cotton cloths this is present in very large amounts, even up to 80 per cent. In such cases the size is composed very largely of china clay, but in better class goods the

size is largely starch, treated by boiling or other methods to increase its viscosity. Further, to render the fibre more supple it is generally treated with some hygroscopic mineral salt, such as magnesium or calcium chlorides, or with glycerine. Such substances are, of course, suitable for plant food, and it is probable that the fungi find their nutriment in this size. The cotton fibres of many of the samples were examined, but no damage could be detected, though in advanced stages of mildew they are said to be affected.

Penicillium, Mucor and *Fusarium*, the three genera of most common occurrence, all possess species having starch-destroying enzymes, and can readily be grown on starchy media. In the cul-

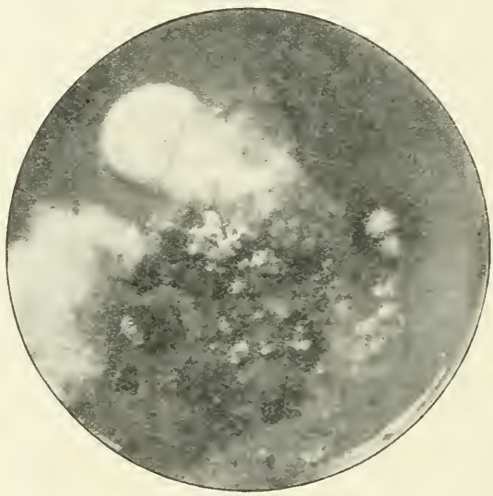

Fig. 1.—Potato agar plate, showing growth of *Fusarium* sp. and *Penicillium glaucum* (dark colonies). Sample XIII.

ture of *Penicillium* on slightly acid potato agar, it was noted that the medium below a colony became at first yellow, then brown, and finally, in an old culture of about 6 to 8 weeks, almost black. This point seems of interest when it is remembered that coloured stains are frequent on mildewed cloth; the brown and grey ones may be due to *Penicillium*. In No. VIII cultures were made from the brown areas, and a very abundant growth of *P. glaucum* obtained (Fig. 2), more so than from the non-stained areas on the sample.

Fusarium is a genus, whose colour producing powers were investigated by Bessey[1] in 1904, who found that several pig-

[1] Bessey, E. A. Über die Bedingungen der Farbbildungbei Fusarium. Flora Vol. 93, p. 301, 1904.

ments were produced dependent upon the acidity or alkalinity of the media, red colours being produced when the medium had an acid reaction. The *Fusarium* found in the isolation cultures of this investigation almost invariably produced a pale crimson coloration of the media in 3 or 4 days, which, as the culture grew older, became in some cases more purplish (7-14 days). After that time the colour either faded away or became a dirty brown as the culture died. A much feebler growth was obtained upon slightly acid peptone broth agar, and no colour was produced.

A biological feature of some interest in regard to both the *Fusarium* and some, at least, of the species of *Mucor* (*M. racemosus*

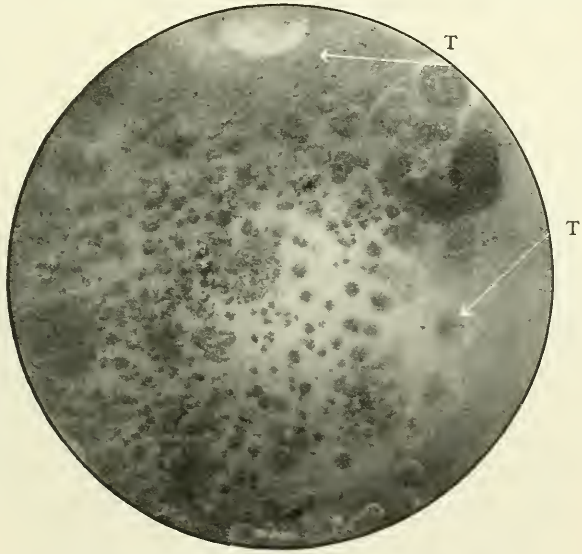

Fig. 2.—Showing colonies of *Penicillium glaucum* also *Torula* sp. at top and on right (T.). Sample VIII.

and *spinosus*) isolated, is that chlamydospores are produced, the resistance of which to dessication doubtless aids the fungi in surviving periods of drought.

Other common saprophytic fungi, such as *Torula* sp., *Stysanus* sp., etc., were found, also in the single case of Sample XI, *Chaetomium murorum*. This fungus only occurred on that one sample (a very badly stained strip of velveteen, probably the outside fold of the length), and it was abundant there while *Penicillium, Mucor* and *Fusarium* were absent. Since bone meal is sometimes used in the sizing of velveteen, the rather different fungus flora obtained from No. XI may be due to that cause.

There are many causes that may render the cotton goods sufficiently damp to permit of fungus growth. A very important factor is the hygroscopic power possessed by textile goods. Over 8 per cent. of moisture on the dry weight of the goods renders them appreciably damp. This amount is reached at ordinary temperatures with a very low relative atmospheric humidity,[1] for example,

with a temperature of 12° C. (53.6° F.) at 66 relative atmospheric humidity.

with a temperature of 24° C. (75.2° F.) at 70 relative atmospheric humidity.

In Lancashire, where the relative humidity is frequently 90 or over, there will be quite 15 per cent. of moisture with a temperature

Fig. 3.—Culture from non-mildewed grey cloth. Besides bacterial colonies, many of which are probably harmless, colonies of *Penicillium glaucum* (P) and *Fusarium* sp. (F) are to be seen.

of 60° F. With any decrease in the temperature the excess of moisture would condense on the inside of the metal-lined packing cases, and render the outer layers of the cotton sodden, an assumption which is borne out by the fact that the inside of the metal lining is frequently rusted, while the outside may still be bright. It is not

[1] Figures taken from a paper by Th. Schloessing fils. on "The Hygroscopic Properties of Textile Materials." *Textile World Record*. Boston. November, 1908.

suggested that the amount of moisture absorbed from the atmosphere in itself would be sufficiently large to enable "mildew" to start in most cases, but that any slight access of water from accidental causes would be more apparent because it falls on cloth already damp, and perhaps provides enough water for fungus growth. Such accidents might be defective packing cases, rain during cartage from mill to warehouse or packing house, insufficient drying, moisture from the large labels frequently attached to the length, etc., while the hygroscopic salts put into the cloth to render it workable will also attract still more moisture. It has not been a part of the present investigation to test the value of any chemical substances which might act as antiseptics or checks to the mildew.

In conclusion, mildew is a defect in cotton goods produced by either fungi or bacteria feeding upon the size (at any rate, in the first case) when conditions are suitable. Of these conditions moisture is probably the determining factor. The fungi and bacteria are common saprophytic species of almost universal distribution, and their spores are possibly present in every piece of cloth exported. Samples of non-mildewed cloth were examined, and growths of *Penicillium, Mucor* spp., *Fusarium*, as well as many species of bacteria, were obtained from them.

The experimental work in connection with this investigation was carried out in the Cryptogamic Research Laboratory, Manchester University, and my thanks are due to Professor W. H. Lang, F.R.S., for the facilities afforded me there.

REMARKS UPON AN APPARENTLY NEW APPLE PEST, *LYGUS PRATENSIS*, LINN.

By

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During the late summer of 1911 a number of apples were submitted to me, with a query as to the cause of certain small dimple-like discoloured areas. To the naked eye these spots had the appearance of the markings of apple scab due to *Venturia inequalis*, Ader., but when more carefully examined it was noticed that there were seldom more than two or three such spots, the fruits being otherwise perfectly clean. Upwards of fifty apples were examined, and all had one, two or three of these characteristic markings. No solution offered itself at the time as to the cause of these external blemishes, nor could I find any reference to similar ones in the literature.

During the present season a careful watch has been kept upon the trees from which the above fruits were picked, with the result that similar spots were found on forming fruitlets, before the petals of the blossom had fallen away. At a later date small fruitlets were more carefully examined, and in the centre of the tiny depression it was noticed that the skin had been punctured and an egg of some insect deposited therein.

A number of such fruitlets were placed in a breeding cage, and eight days later the eggs hatched, and were ultimately identified as the young of the Tarnished Plant-bug (*Lygus pratensis*, Linn.).

On referring to my card catalogue under the heading of this species I found that the subject had been fully worked out and reported upon by Taylor[1] in the United States, but I failed to find any previous record for this country.

My observations fully bear out and corroborate those of Taylor, who states :—

"One small apple was found containing four punctures with eggs, four contained three eggs each, and nine apples bore two eggs apiece. The eggs measured upon an average .782 mm. in length

[1] Taylor, Estes P.—Dimples in Apples from Oviposition of *Lygus pratensis*, L. Journ. Econ. Entom., 1908, vol. 1, pp. 370-375, plts. 10, 11.

by .241 mm. in diameter at their widest point. They were smooth and slightly curved, with the end deepest in the tissue bluntly rounded. The end of the egg nearest the surface was truncate and slightly compressed, and bore around the margin a white tubular fringe, finely striated. The colour was very pale yellow.

The eggs were found laid singly in the fruit, though where very small apples contained several the distance between them was often very small. Sometimes two or three would be found arranged in a row, not more than one millimetre apart, but each egg occupying a separate and distinct incision. The usual rule was that of single and scattering egg punctures. The eggs were placed on end or at right angles with the surface of the apples, snugly fitting into the incisions made for them. These incisions, when made in the sides of the ovaries of blossoms which had but recently shed their petals, were of depth sufficient to pierce the carpel walls. In one instance an egg was found in an incision made within the stem of the miniature apple. Out of thirty-six egg incisions counted, fifteen were in the third nearest the tip or calyx end, thirteen were in the middle third, and eight were made in the third nearest the stem. The eggs were deposited in the apple usually with the outer end just beneath the surface of the skin. Quite often the growth of the tissue of the apple forces the eggs outward lengthwise, and they may often be seen with their whitish truncate tube-like ends extruded into view as much as one-third or one-half the length of the eggs. It is not altogether unlikely that this may be in some cases due to shallow egg-laying by the female. When not extruded in this manner they are difficult to discern, as the heavy pubescence over the minute apples conceals them. Freshly-laid eggs are more difficult to discern, since the tissue surrounding has not become discoloured.

Eggs are laid sometimes before the petals fall from the blossom, and probably some are deposited while still in the bud. No freshly-laid eggs were found in any case after the apples were more than one-third of an inch in diameter, and usually not later than the time of the closing of the calyx."

I have previously seen French Beans and Scarlet Runners similarly damaged by an allied species, but this being the first occasion on which I know of apples being so affected in this country, it seems worthy of recording.

REVIEWS.

Bahr, P. H.—Filariasis and Elephantiasis in Fiji. Pp. viii + 192, 5 plts. and 44 figs. London: Witherby and Co., 1912. Price 6s. net.

Apart from the strictly medical aspect, Dr. Bahr's report is of great interest and value. In the investigation no point of importance seems to have been omitted, and all are fully and carefully described. After discussing in detail the conclusions arrived at, the author deals with a mass of statistical matter in the form of thirty-three appendices, which alone form a most valuable contribution to the subject, and must prove of great service to all future investigators and others who have to deal with this distressing disease.

For some unknown reason the illustrations, instead of being lettered plates and figures, are termed plates and photographs, which is misleading and often confusing. The bibliography on pages 191, 192, might with advantage have been given more fully.

Grandi, G.—Dispense di Entomologia Agraria. Pp. 575, 474 figs. Portici: R. Scuola Sup. D'Agric., 1911.

Under the able direction of Professor F. Silvestri the Entomological Laboratories of the Royal School of Agriculture at Portici have rapidly assumed a world-wide fame. The high standard of the work and the wealth of illustration that always accompanies the same, are highly appreciated by investigators of all nationalities.

Dr. Grandi, the author of the book before us, is a member of the staff of this famous institution, and the style and standard of his work fully maintain its best traditions.

The author commences with a short introduction on the classification of insects, and then at once enters upon the purely systematic portion. Typical insects illustrative of all the Orders are described, keys and tables are given to assist in the determination of the various families, whilst the whole are very fully illustrated by excellent figures.

As a text-book on agricultural entomology, the work is of more than average merit, and it must prove of great value to those for whom it is primarily intended.

Hopkins, C. G.—The Story of the Soil. Pp. 350, and illustrations. London: T. Werner Laurie. [1911]. Price 6s. net.

Whether the farmer will read this book rather than the popular scientific treatise on farm practice is a difficult question to decide. Dr. Hopkins, however, has boldly struck out a new line in appealing to his readers almost in the form of a novel.

The author recounts the story of an agricultural student in search of a farm, the different ones he visits, the problems presented in each, and his final selection of one. There is a fund of practical information presented in a most entertaining manner, which should attract a wide field of readers.

Johns, C. A.—The Forest Trees of Britain. Tenth Edition revised by G. S. Boulger. Pp. xiv + 431, 16 plts. and figs. London: Society for Promoting Christian Knowledge, 1912. Price 6s. net.

Originally published in 1869, this well-known work now enters upon its tenth edition. Of one-volume works there is, perhaps, no other which gives in so readable a form the essential and artistic characters of our forest trees, and the main mass of lore which concerns them, as this work does.

Mr. Boulger, in presenting a revised edition, has brought the work up-to-date, but at the same time has preserved the original much as its author left it. A new series of coloured plates have been added, and the original illustrations, some of great charm, have been retained. In its present form, the book as a non-technical and popular treatise on our forest trees offers a wealth of information in a very acceptable form.

Marshall, A. M., and C. H. Hurst.—A Junior Course of Practical Zoology. 7th ed. revised by F. W. Gamble. Pp. xxxvi + 515, 94 figs. London: Smith, Elder and Co., 1912. Price 10s. 6d.

The late Professor Milnes Marshall's work has been the principle guide of zoological students in this and other countries for upwards of a quarter of a century. The conception of the work was that of a master mind aided by a thoroughly practical assistant, and it bids fair to satisfy the needs of students for many generations to come.

In this, the revised seventh edition, a new chapter on elementary embryology, has been added.

Mason, C. W.—The Food of Birds in India. Edited by H. Maxwell-Lefroy. Mem. Dept. Agric. India, Entom. Ser., 1912, vol. 3, pp. 1-371.

There are few subjects presented to the economic biologist of greater difficulty than that of the beneficial or injurious nature of birds. As Mr.

Mason points out in his introduction, a bird may be injurious to a crop during a portion of a year, but the damage is entirely counteracted by the bird's other feeding habits, especially during the breeding season, when, in some cases, it will be found that vast quantities of caterpillars are destroyed. The food of nestlings is a very important matter. Records of a few casual field observations are usually contrary to the real facts of the case.

The author has examined 1,325 stomachs, embracing 109 species of birds, in 68 cases not more than 10 specimens have been examined and frequently less; in only one case is the number greater than 100, in five cases greater than 50, and in 13 cases greater than 25. Notwithstanding this fact, a considerable amount of useful information has been obtained and very full details given. There is, however, still a wide field for further investigation.

Peabody, J. E., and A. E. Hunt.—Elementary Plant Biology. Pp. xvi + 207, 91 figs. New York: The Macmillan Company, 1912.

Many teachers will welcome a text-book of the character of the one before us. We take it that it is primarily intended for boys and girls in High Schools and similar institutions. As the authors remark, the average boy and girl of fourteen years of age is not interested in biology based primarily on structure, but rather on the activities or functions. The course, therefore, here mapped out is one on physiological lines.

In the hands of a capable teacher this little work should serve a very useful purpose, and lend interest to science teaching in many schools where at present the subject is one least liked and studied.

Sanderson, E. D.—Insect Pests of Farm, Garden and Orchard. Pp. xii + 684, 513 figs. New York: John Wiley and Sons, 1912.

In this work Dr. Sanderson discusses all the more important insects injurious to the farm, garden and orchard crops of the United States of America. After dealing briefly with the injury inflicted upon crops by insect pests; beneficial insects; the structure and development of insects; farm methods for the control of insects; insecticides; and spraying and dusting apparatus, the author enters upon the descriptions of the various insect pests of different plants. In most cases the life-history is described and full particulars given as to the control of the insect.

Many of the insects treated of are common in this country, but, unfortunately, they are given scientific names different to those employed by and known to farmers and fruit-growers here.

Whetham, W. C. D., and C. D.—Heredity and Society. Pp. viii + 190. London: Longmans, Green, and Co., 1912. Price 6s. net.

Both the author and authoress of this work are well known as students of eugenics, and their previous works upon the subject enjoy a deservedly high reputation. Their present contribution may be regarded, to some extent, as extending some of the ideas contained in their earlier work on *The Family and the Nation*, but the bulk of this volume consists of hitherto unpublished work.

The effects produced by the application or disregard of the principles of heredity and the problems or racial degeneracy or advancement, as well as the significant bearing upon society of a nation founded and moulded upon selective influence, are clearly set forth, and with such interest that the work cannot fail but claim the attention of the educated laity.

CURRENT LITERATURE.

I.—General Subject.

Annual Report of the Intelligence Division, Bd. of Agric. and Fisheries. Pt. ii, pp. 74, 9 maps. London, 1911. Price 2s. 1d.

Bulletin of the Bureau of Economic and Social Intelligence. No. 3, pp. xv + 224. Rome: International Institute of Agriculture, 1912.

Bulletin of the Bureau of Agricultural Intelligence and of Plant Diseases. No. 3, pp. xiv + 589-839. Rome: International Institute of Agriculture, 1912.

Dobbs, A. C.—A Priori Suggestions for a Theory of the Incidence of Insect Pests in Agriculture. Agric. Journ. India, 1912, vol. 7, pp. 87-91, 1 fig.

Horticultural Statutes with Court Decisions and Legal Opinions relating thereto, etc. State of California, Sacramento, 1912, pp. 146.

Hunter, W. D.—Results of Experiments to determine the effect of Rontgen Rays upon Insects. Journ. Econ. Entom., 1912, vol. 5, pp. 188-193.

Lefroy, H. Maxwell.—Progress of Economic Entomology in India. Ler Congres Int. d'Entomol. 1910, 1911, pp. 465-482.

Stiles, C. W., and A. Hassall.—Index-Catalogue of Medical and Veterinary Zoology. U.S. Dept. Agric., Bur. of An. Ind., Bull. 39, 1911. Pt. 35, pp. 2655-2703, 1912; pt. 36, pp. 2704-2766.

Summary of Regulations relating to the Importation of Plants, Weeds, and Insects from Great Britain into certain other Countries. Board of Agric. and Fisheries, Miscell. Pub. No. 13, 1912, pp. 113. Price 1d.

II.—Anatomy, Physiology, and Development.

Alt, W.—Über das Respirationssystern von *Dytiscus marginalis*, L. Ein. Beitrag zur Morphologie des Insektenkörpers. Zeit. f. wiss. Zool., 1912, Bd. 99, pp. 357-443, 50 fign.

Cameron, A. E.—Structure of the Alimentary Canal of the Stick-Insect, *Bacillus rosii*, Fabr., with a Note on the Parthenogenesis of this Species. Proc. Zool. Soc. Lond., 1912, pp. 172-182, plts. 28-30.

Günther, K.—Die Sehorgane der Larve und Imago von *Dytiscus marginalis.* Zeit. f. wiss. Zool., 1912, Bd. 100, pp. 60-115, 36 fign.

Pflugstaedt, H.—Die Halteren der Dipteren. Zeit. f. wiss Zool., 1912, Bd. 100, pp. 1-59, Taf. i-iv and 5 fign.

Philiptschenko, J.—Zur Kenntnis der Apterygotenembryologie. Zool. Anz., 1912, Bd. 39, pp. 43-49, 8 fign.

III.—General and Systematic Biology, and Geographical Distribution.

Browne, F. B.—The Aquatic Coleoptera of the South-East of Ireland. Irish Nat., 1912, vol. 21, pp. 1-16.

Carnes, E. K.—An Explanation of the Hibernating Habits of *Hippodamia convergens.* Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 177-188, 7 figs.

Chamberlain, R. V.—The Chilopoda of California. III. Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 650-672, 4 figs.

Crawford, J. C.—Descriptions of New Hymenoptera. No. 4. Proc. U.S. Nat. Mus., 1912, vol. 42, pp. 1-10, 2 figs.

Dyar, H. G.—Descriptions of New Species and Genera of Lepidoptera, chiefly from Mexico. Proc. U.S. Nat. Mus., 1912, vol. 42, pp. 39-106.

Garman, H.—The Catalpas and their Allies. Kentucky Agric. Exp. Stat., Bull. No. 164, 1912, pp. 203-223, 18 figs.

Ghosh, C. C.—Life-histories of Indian Insects. III. The Rhinoceros Beetle (*Oryctes rhinoceros*) and the Red or Palm Weevil (*Rhynchophorus ferrugineus*). Mem. Dept. Agric. India, Entom. Ser., 1911, vol. 2, No. 10, pp. 193-217, plt. xxvii, xxviii, and 2 figs.

Green, E. E.—Note on a Web-spinning Psocid. Spolia Zeylanica, 1912, vol. 8, pp. 71, 72, 1 plt. and 2 figs.

Houard, C.—Les collections cécidologiques du Laboratoire d'Entomologie du Muséum d'Histoire naturelle de Paris; l'Herbier du Dr. Fairmaire. Marcellia, 1912, vol. 11, pp. 11-46, 22 figs.

Imms, A. D.—On the Life-history of *Croce filipennis,* Westw. Trans. Linn. Soc. Lond., 2nd Ser. Zool., 1911, vol. 11, pp. 151-160, plt. 32.

Imms, A. D.—On some Collembola from India, Burma and Ceylon, with a Catalogue of the Oriental Species of the Order. Proc. Zool. Soc. Lond., 1912, pp. 80-125, plts. 6-12 and 2 figs.

Janet, C.—Le Sporophyte et le Gamétophyte du Végétal; le Soma et le Germen de l'Insecte. Fasc. 30. Pp. 65, 7 figs. Limoges, 1912.

Kieffer, J. J.—Nouveaux Chironomides (*Tendipedidae*) de Ceylan. Spolia Zeylanica, 1912, vol. 8, pp. 1-24, 9 figs.

Kieffer, J. J.—Cecidomyies de Ceylan decrites. Ibid., pp. 25-29, 3 figs.

Metcalf, C. L.—Life-histories of *Syrphidae*. Ohio Nat., 1911, vol. 12, pp. 397-404, plt. 19.

Milliken, F. B.—The Position assumed by female Grasshoppers when Ovipositing. Journ. Econ. Entom., 1912, vol. 5, p. 232.

Patton, W. S., and F. W. Cragg.—The Genus *Pristirhynchomyia*, Brunetti, 1910. Anns. Trop. Med. and Paras., 1912, vol. 5, pp. 509-514, plt. xxv.

Patton, W. S., and F. W. Cragg.—The Life-history of *Philaematomyia insignis*, Ansten. Ibid., pp. 515-520, 4 figs.

Payne, F.—*Drosophila ampelophila*, Loew., bred in the Dark for sixty-nine Generations. Biol. Bull. Woods Hole, Mass., 1911, pp. 297-301, 1 fig.

Pearson, J.—Biological Survey of Trincomalee Harbour. Spolia Zeylanica, 1912, vol. 8, pp. 30-40, 4 charts.

Pearson, J.—Survey of Lake Tamblegam, September, 1911. Ibid., pp. 41-51, 7 charts.

Pierce, W. D.—Systematic Notes and Descriptions of some Weevils of Economic or Biological Importance. Proc. U.S. Nat. Mus., 1912, vol. 42, pp. 155-170.

Rohiver, S. A.—Descriptions of New Species of Wasps in the Collection of the United States National Museum. Proc. U.S. Nat. Mus., 1912, vol. 41, pp. 447-478, 24 figs.

Russell, H. M.—A true internal Parasite of Thysanoptera. Proc. Entom. Soc. Washington, 1911, vol. 13, pp. 235-238.

Schrader, W.—Inbreeding of *Junonia coenia* under high temperatures through twenty-two successive generations. Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 673-677, 1 fig.

Silvestri, F.—Contribuzione alla conoscenza dei *Campodeidae* (Thysanura) d'Europe. Boll. Lab. Zool. R. Sc. Agric. Portici, 1912, vol. 6, pp. 110-147, 31 figs.

Amongst others there are two new species from England described and figured.

Stephens, J. W. W.—*Desmogonius desmogonius*, a New Species and Genus of Monostome Flukes. Anns. Trop. Med. and Paras., 1911, vol. 5, pp. 497-500, plt. xxiii.

Strickland, E. H.—Some Parasites of *Simulium* larvae and their Effects on the Development of the Hosts. Biol. Bull. Woods Hole, Mass., 1911, pp. 302-338, plts. 1-5.

Viereck, H. L.—Descriptions of Five New Genera and Twenty-six New Species of Ichneumon Flies. Proc. U.S. Nat. Mus., 1912, vol. 42, pp. 139-153.

IV.—Agriculture and Horticulture.

Arrow, G. J.—On a New Species of Melolonthid Beetle (*Phytalus smithi*) destructive to Sugar Cane. Ann. Mag. N. H., 1912, s. 8, vol. 9, pp. 455-459, i fig.

Bremner, O. E.—Quarantine against Gipsy Moth (*Porthetria dispar*) and Brown-tail Moth (*Euproctis chrysorrhoea*). Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 159-162, 2 figs.

Britton, W. E.—Eleventh Report of the State Entomologist of Connecticut for the Year 1911. Pp. vi + 87, 16 plts. and 10 figs. New Haven, Conn., 1912.

Dr. Britton's reports are always full of interest. The one before us treats of a number of subjects, amongst which mention may be made of an account of the Onion Fly (*Phorbia ceparum*, Meig.), by Mr. D. J. Caffrey, the Periodical Cicada, The Leopard Moth (*Zeuzera aesculi,* L.) and the Pyralid *Omphalocera dentosa,* Grote.

Carpenter, G. H.—Injurious Insects and other Animals observed in Ireland during the year 1910. Econ. Proc. Roy. Dublin Soc., 1911, vol. 2, pp. 31-51, 7 plts. and 6 figs.

Chittenden, F. H.—The Large Canna Leaf-Roller (*Calpodes ethlius,* Cram.). U.S. Dept. Agric., Bur. of Entom., Circ. No. 145, 1912, pp. 1-10, 8 figs.

Chittenden, F. H.—The Southern Beet Webworm (*Pachyzancla bipunctalis,* Fab.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 109, pt. ii, 1911, pp. 17-22, 1 fig.

Chittenden, F. H.—The Fig Moth (*Ephestia cautella,* Walk.). Ibid., Bull. No. 104, 1911, pp. 1-65, plts. i-xvi, 4 figs. With Report on the Fig Moth in Smyrna, by E. G. Smyth.

Chittenden, F. J.—On some Plant Diseases. Journ. Roy. Hort. Soc., 1912, vol. 37, pp. 541-550.

Collinge, Walter E.—Second Report on Economic Biology. Pp. vii + 70, 15 figs. Birmingham: The Midland Educational Co., Ltd., 1912. Price 2s. 6d. net.

Cook, A. J.—Stem-end Rot and Gummosis. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 44, 45.

Cook, A. J.—Boring Insects. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 111-113.

Cook, A. J.—Woolly Aphis—Kerosene Emulsion. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 172-174, 1 fig.

Cooley, R. A.—Ortho Arsenite of Zinc as an Insecticide. Journ. Econ. Entom., 1912, vol. 5, pp. 142-146, 1 plt.

Crawford, D. L.—A Danger to our Citrus Belt. The Mexican Orange Maggot (*Anastrepha* (*Trypeta*) *ludens*). Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 46-49, 2 figs.

Crawford, D. L.—A New Insect Pest (*Trioza alacris,* Flor.). Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 86, 87.

Crosby, C. R.—The Plum Leaf-Miner (*Nepticula slingerlandella,* Kearfott). Agric. Exp. Stat., Ithaca, N.Y., Bull. 308, 1911, pp. 219-227, 14 figs.

Cushman, R. A.—Notes on the Peach and Plum Slug. U.S. Dept. Agric., Bur. of Entom., Bull. No. 97, pt. v, 1911, pp. 91-102, plt. xi and 3 figs.

Davis, J. J.—Important Insects of the Truck Gardens of Illinois, Illinois Farmers' Inst., Circ. No. 4, 1911, pp. 1-50, 42 figs.

Davis, J. J.—The Woolly Aphis (*Phyllaphis? querci,* Fitch). Entom. News, 1911, vol. 22, pp. 241-245, plt. vii.

Doten, S. B.—The European Elm Scale (*Gossyparia spuria,* Modeer.). Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 89-100, 29 figs.

Essig, E. O.—The Walnut Plant Louse (*Chromaphis juglandicola,* (Kalt.), Walker). Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 190-194, 2 figs.

Fawcett, H. S.—Gum Diseases in Citrus Trees. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 147-156, 5 figs.

Felt, E. P.—Recent Experiments with the Codling Moth. Journ. Econ. Entom., 1912, vol. 5, pp. 153-169.

Finlow, R. S., and J. H. Burkill.—The Inheritance of Red Colour, and the regularity of Self-fertilisation, in *Corchorus capsularis,* Linn., the Common Jute Plant. Mem. Dept. Agric. India, Bot. Ser., vol. iv, No. 4, 1912, pp. 73-92.

Fletcher, T. B.—The Cabbage White Butterfly (*Pieris brassicae*). Agric. Journ. India, 1912, vol. 7, pp. 1-4, plt. i.

Forbes, S. A.—Twenty-sixth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois, 1911. Pp. xix + 160, 41 figs.

French, C., junior.—The Light Brown Apple Moth (*Tortrix* (*Cacaecia*) *responsana*). Journ. Dept. Agric. Vict., 1912, vol. 10, pp. 111-113, fig.

Gammon, E. A.—Pear Blight Control. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 37-41, 3 figs.

Garman, H.—A Preliminary Study of Kentucky Localities in which Pellagra is Prevalent, having Reference to the Condition of the Corn Crop and to the Possible Presence of an Insect or other Agent by which the Disease Spreads. Kentucky Agric. Exp. Stat., Bull. No. 159, 1912, pp. 3-79, 65 figs.

A very valuable paper, with a wealth of entomological information.

Guppy, P. L., and T. Thornton.—The Cotton Stainer Bug (*Dysdercus howardi* and its variety *minor*). Bd. of Agric. Trinidad, Circ. No. 6, 1911, pp. 1-23, 1 plt. and 11 figs.

Hardenberg, C. B.—San Josè Scale in the Transvaal (*Aspidiotus perniciosus*, Comstock). Agric. Journ. of South Africa, 1911, vol. 2, pp. 256-263.

Headlee, T. J.—The Time when Wheat should be sown to escape the Fall Brood of Hessian Fly. Journ. Econ. Entom., 1912, vol. 5, pp. 98-109, 2 figs.

Herrick, G. W.—The Fruit-tree Leaf-Roller, with Notes on Allied Forms. Cornell Univ., Agric. Exp. Stat., Dept. Entom., Bull. 311, 1912, pp. 279-292, 18 figs.

Hindle, E.—On the Life-cycle of *Spirochaeta gallinarum*. Parasitology, 1912, vol. 4, pp. 463-477, 6 figs.

Hole, R. S.—On some Indian Forest Grasses and their Oecology. Ind. For. Mem., For. Bot. Ser., 1911, vol. i, pt. i, pp. ii + 126, 40 plts.

Hopkins, A. D.—The Dying Hickory Trees: Cause and Remedy. Ibid., pp. 1-5, 4 figs.

Houser, J. S.—The Gooseberry Gall Midge or Bud Deformer. Journ. Econ. Entom., 1912, vol. 5, pp. 180-184, plts. 5, 6.

Hunter, W. D.—The Movement of the Mexican Cotton Boll Weevil in 1911. U.S. Dept. Agric., Bur. of Entom., 1912, Circ. No. 146, pp. 1-4, 1 fig.

Hunter, W. D.—The Outbreak of *Alabama argillacea* in 1911. Journ. Econ. Entom., 1912, vol. 5, pp. 123-131.

Jepson, F. P.—Report on Economic Entomology. Pp. 89, 6 plts. Council Paper No. 25. Dept. Agric. Fiji, 1911.

Marsh, H. O.—The Hawaiian Beet Webworm. (*Hymenia fascialis*, Cram.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 109, pt. i, 1911, pp. 1-15, plts. i, ii and 2 figs.

Merrill, G. E.—How to Fight the Pear Thrips. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. i, pp. 51-59, 3 figs.

Merrill, G. E.—The Control of Scales and Lichens on Deciduous Trees. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 113-115.

Metcalf, H.—The Chestnut Bark Disease. Journ. Econ. Entom., 1912, vol. 5, pp. 222-230, plt. 7.

Morrill, A. W.—The Citrus Thrips, with reference to other species affecting Citrus. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 162-171, 7 figs.

Newcomer, E. J.—Root-Knot. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 81-85, 6 figs.

Parrott, P. J.—The Occurrence of the Pear Thrips in New York. Journ. Econ. Entom., 1912, vol. 5, pp. 184-188.

Parrott, P. J.—The Pear Thrips. Bull. No. 343. New York Agric. Exp. Stat., 1912, pp. 1-28, 1 plt. and 10 figs.

Pethybridge, G. H.—Investigations on Potato Diseases. Third Report. Journ. Dept. Agric. Ireland, 1912, vol. 12, pp. 1-28, 5 figs.

Prizer, J. A.—Two Methods of Controlling Citrus Mites. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 174-176, 1 fig.

Quaintance, A. L.—Notes on the Peach Bud Mite (*Tarsonemus waitei,* Banks, MSS.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 97, pt. vi, 1912, pp. 103-114, plts. xii-xvi.

Quayle, H. J.—The Purple Scale (*Lepidosaphes beckii,* Newm.). Univ. Calif. Agric. Exp. Stat., Bull. No. 226, 1912, pp. 317-340, 12 figs.

Rao, M. R.—Host Plants of the Sandal Tree. Ind. For. Records, 1911, vol. 2, pt. 4, pp. 159-207, plts. i-viii.

Ross, R., and E. S. Edie.—Some Experiments on Larvicides. Anns. Trop. Med. and Paras., 1911, vol. 5, pp. 385-390.

Taylor, T. H.—Cabbage-Top in Swedes. Bull. No. 82, pp. 3-21, 5 plts. and 11 figs. University of Leeds, 1912.

The condition of swedes generally known as "Cabbage-top" or "Cabbage-head," has long been the subject of speculation, and in the present paper Mr. Taylor shows that the chief cause of this condition is due to the larvae of *Contarinia nasturtii,* Kieffer, feeding upon the young leaves of the plant.

The life-history, effect upon the crop, and preventive measures are fully described and beautifully illustrated.

Watson, J. R.—Utilization of Fungous Parasites of *Coccidae* and *Aleurodidae* in Floridae. Journ. Econ. Entom., 1912, vol. 5, pp. 200-204.

Weinland, H. A.—The Fruit Fly Menace and Preventive Measures. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 156-159.

V.—Forestry.

Burdon, E. R.—The Study of Timber and Forest Products in America. Pp. 24. Cambridge University Press, 1912. Price 6d.

This is a report presented to the Forestry Committee of the University of Cambridge on a visit to the United States and Canada, for the purpose of studying the research work and educational methods of the forestry departments of the forestry schools in those countries, in connection with the study of timber and forest products.

Burgess, A. F.—Some Shade Tree Pests in Massachusetts. Journ. Econ. Entom., 1912, vol. 5, pp. 172-180, 2 plts.

Herrick, G. W.—Notes on Three Shade Tree Pests. Journ. Econ. Entom., 1912, vol. 5, pp. 169-172.

Hopkins, A. D.—Insect Damage to Standing Timber in the National Parks. U.S. Dept. Agric., Bur. of Entom., Circ. No. 143, 1912, pp. 1-10.

Pearson, R. S.—Note on the Antiseptic Treatment of Timber in India, with special reference to Railway Sleepers. Ind. For. Rec., vol. iii, 1912, pp. vii + 107, plts. i-ix.

Singh, P.—Note on the Resin-Value of *Podophyllum emodi* and the best season for collecting it. For. Bull. No. 9, Calcutta, 1912, pp. 1-5.

Stebbing, E. P.—Insect Pests of the Chir Pine (*Pinus longifolia*) in the North-West Himalaya, with Brief Notes on the Insects Predaceous and Parasitic upon them. Indian For. Memoirs, For. Zool. Ser., 1911, vol. 2, pt. 2, pp. 1-39, plts. xv-xxiii.

VI.—Fisheries.

VII.—Medicine.

Brunetti, E.—*Aphiochaeta ferruginea*, a hitherto undescribed Species of *Phoridae* that causes Myiasis in Man. Rec. Ind. Mus., 1912, vol. 4, pp. 83-86.

Knab, F.—Unconsidered Factors in Disease Transmission by Blood-Sucking Insects. Journ. Econ. Entom., 1912, vol. 5, pp. 196-200.

Martin, C. H.—A Note on the Early Stages of Nuclear Division of the Large Amoeba from Liver-abscesses. Q. J. M. S., 1911, vol. 57, pp. 279-281, 7 figs.

Seidelin, H.—Notes on some Blood-Parasites in Man and Mammals. Anns. Trop. Med. and Paras., 1912, vol. 5, pp. 501-508, plt. xxiv.

VIII.—Animal Diseases, Etc.

Carnes, E. K.—A Serious Chicken Pest. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 136-139, 6 figs.

Fantham, H. B.—*Herpetomonas pediculi,* nov. spec., Parasitic in the Alimentary Tract of *Pediculus vesmenti.* Proc. Roy. Soc., 1912, B. vol. 84, pp. 505-517.

Fantham, H. B.—Some Researches on the Life-cycle of Spirochaetes. Anns. Trop. Med. and Paras., 1911, vol. 5, pp. 479-496, 6 figs.

Hunter, W. D., and F. C. Bishopp.—The Rocky Mountain Spotted Fever Tick, with special reference to the problem of its control in the Bitter Root Valley in Montana. U.S. Dept. Agric., Bur. of Entom., Bull. No. 105, 1911, pp. 1-47, plts. i-iii, 3 figs.

Jennings, A. H.—Some Problems of Mosquito Control in the Tropics. Journ. Econ. Entom., 1912, vol. 5, pp. 131-142.

Kinghorn, A., and W. Yorke.—On the Transmission of Human Trypanosomes by *Glossina morsitans,* Westw.; and on the Occurrence of Human Trypanosomes in Game. Anns. Trop. Med. and Paras., 1912, vol. 6, pp. 1-23.

Liston, W. G., and C. H. Martin.—Contributions to the Study of Pathogenic Amoebae from Bombay. Q.J.M.S., 1911, vol. 57, pp. 107-128, plts. 16-18.

Newell, W.—Practical Information for Beginners in Beekeeping. Revised edition. Bull. No. 142, Texas Agric. Exp. Stat., 1911, pp. 1-46, 22 figs.

Ransom, B. H.—The Nematodes Parasitic in the Alimentary Tract of Cattle, Sheep, and other Ruminants. U.S. Dept. Agric., Bur. Anim. Ind., Bull. 127, 1911, pp. 1-132, 152 figs.

An invaluable publication, profusely illustrated, and well indexed.

Report on the Isle of White Bee Disease (*Microsporidiosis*). Suppl. Journ. Bd. Agric., 1912, vol. xix, pp. 1-143, 6 plts. and 2 figs.

Seidelin, H.—Notes on some Blood Parasites in Reptiles. Anns. Trop. Med. and Paras., 1911, vol. 5, pp. 371-384, plts. xiv, xv.

Yorke, W., and B. Blacklock.—The Trypanosomes found in Two Horses naturally infected in the Gambia. Anss. Trop. Med. and Paras., 1911, vol. 5, pp. 413-434, plt. xviii.

IX.—Commercial.

Brown, Adrian J.—Brewing and Modern Science. Nature, 1912 (Jan. 18), pp. 391-393, 5 figs.

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THE

JOURNAL OF ECONOMIC BIOLOGY.

ON THE CULTIVATED AND WILD FORMS OF COCHINEAL INSECTS.

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With Plate I.

Until the appearance of Mrs. Fernald's *Catalogue of the Coccidae of the World*, the generally accepted name of the Cochineal Insect of Commerce was *Coccus cacti*. I have retained this well-known name, in the present paper, although we are now told that the genus *Coccus* is preoccupied for the species that we had hitherto known by the generic name of *Lecanium*, and the name *Dactylopius*, that we have been accustomed to apply to a large group of the "Mealy Bugs," should be transferred to the Cochineal insect. Even the specific name *cacti* has been disallowed in favour of *coccus*, and—in the general shuffle of familiar names—this important insect, which had assumed a position of the arch-type of the family *Coccidae*, has been dethroned and disguised as *Dactylopius coccus* of Costa. However much this ruling may be justified by the strict laws of nomenclature, the loss of such a distinctive and well established name as *Coccus cacti* is greatly to be deplored.

The cultivated form of Cochineal, known to commerce as "grana fina," can be distinguished readily by its large size, by the profusion of conspicuous thick-rimmed pores, and by its comparative freedom from the truncate spines that are so characteristic of the wild forms ("grana sylvester"). I recognize this form as *Coccus cacti*, auct.

Four species and one sub-species of the wild cochineal have been distinguished and described by various authors. These are:—

Coccus tomentosus, Lam. (1835).

Hab.—New Mexico, Arizona, Mexico. Taken also by Newstead in the plant houses of the Royal Botanic Gardens, Kew.

Coccus confusus, Ckll. (1893).

Hab.—New Mexico, Arizona, Mexico.

Coccus confusus newsteadi, Ckll. (1898).

Hab.—Arizona, Colorado, Texas.

Coccus argentinus, Dominguez. (1907).

Hab.—Argentina.

Coccus indicus, Green. (1908).

Hab.—India, Ceylon.

To this list I would add another sub-species, *Coccus confusus capensis*, from South Africa.

With the exception of *C. argentinus*, I have been able to examine typical examples of all these supposed species, and it must be confessed that a careful study of them reveals no sharp characters by which they may be defined. I am inclined to regard all these wild forms as comparatively recent derivatives of *tomentosus*, differing but slightly in the proportions of the limbs and the shape of the truncate spines. The Indian and African forms were almost certainly introduced from the Neotropical regions of America, and may have become slightly differentiated under the altered conditions. *Coccus cacti*, on the other hand, has characters so distinct as to make it probable that its segregation dates from a much earlier period. For the present I have retained the specific names by which the several forms have been recognized.

The following synopsis is an attempt to differentiate the several forms; but the characters are not sharply defined and are subject to a certain amount of variation. Moreover, as these characters are mostly relative, they are of use only when the different forms are available for comparison.

A. Large species, spines few and small, glandular pores large and thick-rimmed, approximately naked, eyes cylindrical, longer than broad ... ... *CACTI*.

B. Smaller species, spines numerous and comparatively large, glandular pores small and without thick rims, eyes rounded, shorter than broad, covered with white mealy tomentum

(*a*) Seventh joint of antenna sub-globular, as broad as long, glandular pores in comparatively small clusters, spines stout, with very broad bases *INDICUS*.

(*b*) Seventh antennal joint longer than broad, glandular pores in comparatively large clusters, spines rather more elongate.

(*a'*) Antennae and limbs very small, antennal joints much contracted *TOMENTOSUS.*

(*b'*) Antennae and limbs somewhat larger, antennal joints broader and more extended ... ... *CONFUSUS.*

(*CONFUSUS NEWSTEADI*).

(*CONFUSUS CAPENSIS*).

I have been unable to include *Coccus argentinus* in this synopsis, as I am completely ignorant of its special characters, having been unable to procure examples of the species or a copy of the paper in which it was described.

The Cochineal insects may be distinguished generically by the following characters:—Female without ciliated anal ring or anal lobes. Antenna normally with 7 joints, the number occasionally reduced by the confluence of two or more segments. Derm with irregular clusters of glandular pores and truncate spines. Eyes prominent, simple. Legs well developed. The truncate spines are cylindrical and apparently tubular. They are very numerous on the wild forms, but are greatly reduced—both in number and size—on the cultivated species. The cultivated cochineal insect secretes very little of the woolly tomentum that is so noticeable in the wild forms. A corresponding difference in the dermal characters suggests that the truncate spines are concerned in the secretion of this woolly matter, while the glandular pores probably excrete the fine waxy powder to which the pruinose appearance of the cultivated form is due.

As regards the economic value of the several forms, Professor Cockerell, in a discussion on *Coccus confusa*,[1] appends the following note:—"Mr. Clarence E. Rhodes, one of my students in zoology, has been working out the relative amounts of pigment, weight for weight of the insects gathered, in the different forms of *Coccus*. Following a method suggested by Professor Goss, chemist of the New Mexico Agricultural Experiment Station, it was ascertained that taking commercial *C. cacti* as 100 the pigment in the same weight of *tomentosus* (*opuntiae*) from Guanajuato was equivalent to 80, while that of *C. confusus* from Las Cruces was equivalent to only 16. It is evident that *confusus* is of practically no commercial value."

[1] "Notes and Descriptions of the New Coccidae collected in Mexico by Prof. C. H. T. Townsend." Bull, No. 4 Tech. Ser., U.S. Dept. Agric., p. 35.

The following specific characters have been drawn up from examples that I have personally examined, supplemented by descriptions from other authors.

Coccus cacti, auct. (= *Dactylopius coccus*, Costa).

Pl. 1, figs. 1a-1g.

Adult female sub-globular, slightly narrower behind. Purplish red, pruinose, but without conspicuous white tomentum.

Eyes (fig. 1—a) prominent, cylindrical, rugosely chitinous.

Antennae (fig. 1—b) short, basal joints very broad, others narrowing successively, 7-jointed, 1st joint very irregular in form, 2nd joint represented by a broad chitinous ring, 3rd and 4th usually more or less confluent, the junction incompletely demarked by bands of translucent intersegmental tissue, 5th broad and short, 6th approximately equal in breadth and length, 7th elongate, twice as long as broad, with some stout curved hairs on the apical half, a few stout spiniform hairs on the apical margins of the other joints with the exception of the 3rd, rarely 6-jointed by suppression of the 5th or 6th joint. Length of antenna 0.2 to 0.3 mm. Breadth of basal joint 0.16 mm.

Legs (figs. 1—c, d, e) stout, terminating in a slender, longish curved claw, femur and trochanter together 0.38 mm., tibia 0.16 mm., tarsus (without claw) 0.15 to 0.16 mm.

The most conspicuous feature of the derm is the presence of numerous clusters of large, thick-rimmed pores (fig. 1—f), each with a pentagonal lumen, which occur over the whole surface, but are less pronounced on the median area. The number of pores in a cluster varies from 2 to 25, and averages 12 or 13.

The truncate spines (fig. 1—g) are very inconspicuous, small and slender, tapering slightly towards the extremity, some of them almost hair-like. They are scattered very sparsely over the body, but are grouped more closely on the area surrounding the anal orifice, where they are mingled with some simple pointed hair-like spines.

Length of adult female (under compression) from 4 to 6 mm. Breadth, 3 to 4.5 mm. Average dimensions 4.75×3.87.

Signoret describes the adult male as follows:—

"The male is of a reddish yellow colour, darker on the head and thorax, with the feet and antennae brown, and the wings grayish white. The head is thick, rounded, pointed between the antennae, with four glossy eyes and two ocelli. (The larger and more conspicuous simple optic organs of male Coccidae are now usually regarded as homologous with the ocelli of other insects, while

the smaller—and often rudimentary—single pair represent the true eyes. E. E. G.). The antennae are 10-jointed, with the 4th, 5th and 10th longest, and with a short pubescence on all the joints, the hairs somewhat truncate; at the apex of the 5th and following joints one sees a larger pubescence formed of hairs knobbed at the extremity; the 1st and 2nd joints, almost smooth, have only one or two hairs; this is a character that we have not noticed in any other genus. The legs are very long, with a scanty pubescence formed of small hairs scattered on the disc and sides; the tarsus is one-third shorter than the tibia, and bears two very long digitules; the claw is very slender and long, with the two digitules extending slightly beyond it. The abdomen, which is paler, has on each segment a transverse line of small hairs; the lateral lobes of the extremity bear a protuberance occupied by a great number of spinnerets and three hairs, around which is agglomerated the matter of the two fragile filaments of the extremity, which are sometimes twice as long as the body of the insect; between the two filaments one finds the copulatory armature, composed of a very stout tubercle accompanied by a hook-shaped stylet below. On the middle of the abdomen there is sometimes a small brown spot on each segment, forming together a longitudinal stripe. On the prothorax—in front—is a dark transverse band, as also on the meso and metathorax, and sometimes three longitudinal stripes from the neck to the metathorax. Below, the sternal plates are browner. After studying many individuals, we have been unable to see any halteres. The elytra (wings) extend for one-third (their length) beyond the abdomen, with the extremity broadly rounded; the veins are brownish yellow, with a reddish tint on the border."

Distribution.—Signoret gives Mexico as the original home of the species, but remarks that the needs of commerce have led to its cultivation in many countries, amongst others in the Canary Islands, in Algeria, and in Spain. Mrs. Fernald quotes Mexico, West Indies, Madeira, Canary Islands, Peru, India, Southern Spain and other European countries, Florida, and California. Mr. I. Burkill (Reporter on Economic Products to the Government of India) has shown that Cochineal insects were introduced into India at various times between the years 1795 and 1883; but it appears that most of these importations consisted of the inferior wild form (then known as "grana sylvester"). But I believe that the true cultivated form ("grana fina") was really introduced on several occasions, though it does not seem to have established itself permanently. I possess examples of typical *Coccus cacti,* from the collection of the

late F. Moore, labelled "Hyderabad, Sind." This form has also been introduced into South Africa, where—I am informed by Mr. Lounsbury—it breeds only on *Opuntia tuna*; but, according to Burkill, *O. tuna* does not occur at the Cape. An inferior form also occurs abundantly on wild cactus (? *O. monacantha*) at the Cape of Good Hope, but the history of its introduction has apparently been lost. Mr. Lounsbury sent me living examples of both forms; but the cultivated insect failed to establish itself, though the wild form has produced a flourishing colony on an isolated Cactus tree in my garden and has remained there for the last ten years. I refer to this form, below, as *C. confusus capensis*.

Mrs. Fernald gives "*Opuntia coccinellifera* and other species" as the food of *C. cacti*. Burkill arrives at the conclusion that this species was cultivated in India upon imported plants of *Opuntia cochinellifera*.

I have personally examined and compared examples from the following sources:—

Guatamala: as prepared for the market: ex coll. R. Eram.
Mexico: Do. do. : ex druggist's store, London.
Hyderabad, India: ex coll. F. Moore.
Cape Colony: living examples: ex coll. C. P. Lounsbury.

Coccus indicus, Green.

Pl. 1, figs. 2a-2g.

C. indicus, Green, Mem. Dept. Agric. Ind., 1908, ii, 2, p. 28.
C. cacti var. *ceylonicus*, Green, Ind. Mus. Notes, 1896, iv, 1, p. 7. Nom. nud.

Adult female sub-globular; purplish red, the colour concealed beneath a mass of white mealy tomentum.

Eyes (fig. 2—a) moderately prominent, rounded, not densely chitinous.

Antennae (figs. 2—b. bb) short, tapering gradually to extremity; 7-jointed (rarely 6-jointed, through the complete confluence of 3rd and 4th joints); all the segments broad and short, much broader than long, with the exception of 7th, which is irregularly sub-globular—the breadth approximately equal to the length; some stout curved hairs on terminal segment. Length of antenna 0.12 to 0.16 mm. Breadth of basal joint 0.06 to 0.08 mm.

Legs (figs. 2—c, d, e) small, moderately stout; femur and trochanter together 0.16 to 0.2 mm.; tibia 0.06 to 0.09 mm.; tarsus (minus claw) slightly longer than tibia, 0.08 to 0.1 mm.

The dermal pores (fig. 2—f), which are such a conspicuous feature in *C. cacti*, are small and inconspicuous in this species, and

are without thickened chitinous rims. They occur singly and in small clusters of 3 or 4 pores; rarely clusters of 5 or 6 occur.

The truncate spines (fig. 2—g) are very numerous and conspicuous—even under a comparatively low magnification. They are short and stout, cylindrical and parallel sided, with very broadly expanded bases which give a characteristic appearance to the spines of this species. The base is usually as broad as, and sometimes slightly broader than, the total length of the spine. They are scattered thickly and evenly over the whole dorsum and on the ventral marginal area of the abdomen. The largest spines are grouped on the abdominal margin.

Length of body (under compression) of Indian examples varies from 2.5 to 5 mm. An average of 19 examples gives a dimension of 3.93 × 3.16 mm. Ceylon examples are slightly smaller, ranging from 1.75 to 4 mm., with an average (from 17 examples) of 2.95 × 2.37 mm.

Distribution.—India and Ceylon. My collection contains examples from the Kangra Valley (ex coll. I. Burkill) and from the Madras Museum (exact locality uncertain), in India; and from Hambantota and Tangalla, in Ceylon.

In India, according to Burkill, this form infests *Opuntia monacantha* and neglects *O. dilleniae*. Only a single species of *Opuntia* (*O. dilleniae*) is recorded from Ceylon. If this is correct, *C. indicus* occurs upon *dilleniae* here. It is now by no means a common insect in Ceylon, and I have found it only upon an isolated plant here and there, though there are records that—many years ago—it killed down all the wild cactus plants in the Jaffna Peninsula. Tryon (*Queensland Agricultural Journal,* vol. xxv, part 4, Oct., 1910, p. 188) and Burkill (*Records of the Botanical Survey of India,* vol. iv, No. 6, 1911) have investigated the history of the introduction of the wild Cochineal insect (presumably the form under discussion) into India. It appears, from Tryon's account, that "in 1795 a Captain R. Neilson brought to India from Brazil some cochineal insects of the kind called by Americans *Sylvestre* and delivered them to Dr. Roxburgh, the Superintendent of the East India Company's Botanical Gardens at Calcutta. A portion of the cochineal insects imported by Captain Neilson was forwarded to Madras, addressed to Dr. J. Anderson, the Company's Physician-General there. The cultivation of this cochineal insect was freely encouraged by the Madras Government, 1796—1809, the East India Company buying the cochineal that was raised, and extensively exporting it to England, where it was known in the trade as 'Madras Cochineal.'

A second introduction of the Wild Cochineal or *Sylvestre* was made, also—in 1821-2—by G. A. Prinsep. When formerly resident at Vera Cruz he had found the Wild Cochineal (that he mistook for the *Grana fina*) growing in an experimental plantation of some extent at Campeachy. Some of this he took with him to England, establishing the insect on *Opuntia* at the Botanical Gardens at Chelsea. From the latter place, in 1821 and again in 1822, he transferred it to Bombay. On his arrival there he found that it was identical with the Wild Cochineal or *Sylvestre* that was already common in India—evidently the result of Captain Neilson's 1795 importation. The fact of these introductions of the *Sylvestre* Cochineal seems, however, to have been forgotten. Thus in January, 1836, F. P. Strong sent to the Agricultural and Horticultural Society of India some native cochineal made from the insect procured from the uncultivated lands at Russa-puglah; and G. Evans, reporting on it in March of the same year, stated that he was of the opinion that it was the wild indigenous *Coccus cacti* of the country, from the circumstance of its being so generally diffused over all parts of India. A third introduction of the Wild or *Sylvestre* Cochineal insect to India took place in 1836. This was effected by Captain Charlton from the Cape of Good Hope; Baron Ludowigne having previously received it in about 1832 at the latter place from Hamburgh, and established it there. Captain Charlton's consignment was placed in the East India Company's Garden at Calcutta. The source beyond Hamburgh from which the Cape of Good Hope Wild Cochineal—received there about the year 1832—emanated, is not now ascertainable. Moreover, there are some grounds for concluding that it was a distinct kind from that which has been naturalised so long in India and Ceylon."

Burkill supplies some additional information. He remarks:—"When Captain Neilson's race of the cochineal insect had reached Madras in 1795, and was known from the Bengal experiments as well as from experiments made by Dr. Andrew Berry to grow freely on an Opuntia plentiful in the country side, but not well or not better on their imported Opuntias, the Collectors of Revenue of that Presidency were each supplied with a small quantity of the insect and directed to exert themselves in the most strenuous manner to get it propagated, and for its maintenance they were to enclose spots of ground fifty or sixty feet square here and there in convenient villages. Next they were instructed to offer a price for the produce to induce villagers to collect and prepare the insects. By their collecting 4,393 lbs. were sent to London in 1797, and 36,388 lbs. in

1798. From reports made on the cochineal raised in India, it appeared that at least four times as much was required to give the same colour as the best Mexican grana fina. Therefore those interested in India were not satisfied—and the result of their dissatisfaction was the importation of other supplies of the insect and of other Opuntias. Further, the price obtained dropped to one-third of what it had been, making the purchase unremunerative and compelling the Government to discontinue their policy, which they did gradually, taking only 8,000 lbs. in 1809 and 4,000 lbs. in 1810."

From these quotations, it would seem probable that the wild Indian cochineal, as it exists to-day in India and Ceylon, has resulted from early introductions of the insect from South America. The question is—from which species? I have had no opportunity of comparing it with *argentinus*, but it is differentiated from either *tomentosus* or *confusus*, in the character of the spines, the form of the terminal antennal joint, and the arrangement of the dermal pores. Tryon—as quoted above—mentions an introduction of wild cochineal insects into India from the Cape of Good Hope; but the form under consideration differs—in the same characters—from present day examples of the South African insect which I am unable to separate satisfactorily from *confusus*.

With the probability of a South American origin, the name *indicus* which has been allotted to this form may perhaps be considered an unfortunate one. When my description was published (in 1908) I was not in possession of the history of the early attempts to establish the cochineal industry in India. But, once published, the name must remain. Moreover, if this origin is finally accepted, the fact remains that the present wild cochineal of India and Ceylon has become differentiated from the parental stock and has now assumed a racial form.

In the *Catalogue of Recently Described Coccidae*, part ii, compiled by J. G. Sanders, preference is given to the name *ceylonicus*, on the strength of a reference to a *Coccus cacti* var. *ceylonicus* in a Catalogue of Ceylon Coccidae published in the *Indian Museum Notes*, in 1896. But that name, issued without any diagnosis, can only rank as a "nomen nudum," and may be disregarded.

Coccus tomentosus, Lamarck.

Pl. 1, figs. 3a-3g.

Coccus tomentosus, Lam., Hist. Nat. Anim., Ed. ii, 1835, iv, p. 115.
Coccus cacti var. *opuntiae*, "Licht," Ckll., Bull. 4, Tech. Ser., U S. Dept. Agric., 1896, p. 35.

Adult female, as described by Newstead from living examples, "slightly elongate ovate, dark crimson, completely covered with

white cottony material." Dried examples, received from the U.S. Department of Agriculture, are sub-globular, purplish red, surrounded by and concealed beneath profuse white secretionary matter.

Eyes (fig. 3—a) moderately prominent, ovate, not densely chitinous.

Antennae (figs. 3—b, bb) very short, tapering rather sharply to the extremity, normally 7-jointed. Newstead gives 6 joints only; but in all my examples received from him, 7 joints can be clearly distinguished, though—owing to their shortness and to the contracted condition of all the joints—one or more of them may be partially obscured. All the first six joints are much broader than long, often consisting of a narrow chitinous ring; the 7th joint oblong, of very irregular form, narrowed at extremity, the length about one and a quarter times the greatest breadth. A group of stout, curved hairs on the apex of the 7th, and a few similar hairs on the preceding three joints. Length of antenna 0.10 to 0.11 mm. Breadth of basal joint, 0.06 to 0.07 mm.

Legs (figs. 3—c, d, e) very small, moderately stout; femur and trochanter together 0.12 to 0.16 mm.; tibia 0.06 to 0.07 mm.; tarsus (minus claw) 0.06 to 0.08 mm.

The dermal pores (fig. 3—f) are small and inconspicuous, as in *indicus,* but occur in somewhat larger clusters containing from 2 to 16, the average number being about 6. There are many scattered single pores.

The truncate spines (fig. 3—g) are numerous and conspicuous. They vary in form from quite slender to short, broad, and cylindrical, the latter being disposed in groups on the margins of the abdominal segments. In examples from the Kew Gardens the slender form of spine is more numerous than the stout form.

Length of body (under compression) from 2 to 3 mm. Breadth from 1.5 to 2.5 mm. An average of eight examples gives a dimension of 2.5 × 2 mm.

Distribution.—In Mrs. Fernald's "Catalogue" this species is recorded from "England, New Mexico, Arizona, Mexico," on *Opuntia fulgida.* The first-named locality is presumably on the strength of Newstead's specimens, taken on the same plant, in the plant houses at the Royal Botanic Gardens, Kew. Prof. Newstead remarks that "all the specimens were found on a plant recently imported from Arizona, and were probably freshly introduced." He adds particulars of an earlier record of what he believes to have been the same species, "discovered on *Cactus cochinillifer,* in the Succulent House at Kew in the year 1827." Possibly these may

have been descendants of the cochineal insects brought from Vera Cruz by Prinsep and established at Chelsea in 1821, as described by Tryon.

I have examined examples from the collection of the U.S. Department of Entomology, labelled "St. Louis, 3—ix—1904," and from Newstead's gathering at Kew.

Coccus confusus, Cockerell.

Pl. 1, figs. 4a-4g.

Coccus confusus, Ckll., Tr. Amer. Ent. Soc., 1893, xx, p. 366.
Coccus cacti subsp. *confusus*, Ckll., Bull. 4, Tech. Ser., U.S. Dept. Agric., 1896, pp. 34, 35.

Adult female concealed beneath a thick covering of white mealy secretion; circular or very broadly oval; sub-globular. Cockerell describes this form as being "smaller than *cacti*, and enveloped in profuse secretion."

Eyes (fig. 4—a) moderately prominent, not densely chitinous.

Antennae (fig. 4—b) small; basal joint very broad and of irregular form; 2nd joint consisting of a shallow chitinous ring; 3rd and 4th longer, but length less than breadth; 5th and 6th much smaller, each twice as broad as long; 7th narrowest, elongate oval, irregularly tuberculate, with the usual stout hairs on the apical half; a ring of stout hairs on apex of 6th, and one or two smaller hairs on anterior margin of 4th and 5th. Cockerell, *loc. cit.*, says "antennae 7-jointed in well-developed individuals; joint 4 decidedly longer than in Signoret's figure of *cacti*." This difference must be understood as being relative rather than actual. Total length of antenna 0.16 mm. Breadth of basal joint, 0.06 to 0.08 mm.

Legs (figs. 4—c, d, e) small, moderately stout; femur and trochanter together 0.18 to 0.21 mm.; tibia 0.08 mm.; tarsus (without claw) 0.09 to 0.12 mm.

The dermal pores (fig. 4—f) are small, but moderately conspicuous, occurring in large clusters ranging from 3 to 36. A count of twenty-four clusters near the posterior extremity of the body (where the clusters are larger) shows an average of 15 pores per cluster.

The truncate spines (fig. 4—g) are numerous and conspicuous, especially on the hinder part of the body. They are stout, elongate, cylindrical, with slightly expanded bases; the diameter of base half (or slightly more than half) the total length of the spine.

Length of body (under compression) from 3.5 to 4.75 mm. Breadth 2.75 to 4 mm. An average of nine examples gives a dimension of 4.11 × 3.52.

Distribution.—Arizona, New Mexico, Mexico. Cockerell (*loc. cit.*, p. 34) gives as locality for his Coccus cacti subsp. cofusus, "Near Arroya, Texas: on Opuntia."

I have examples ex coll. U.S. Department of Entomology, labelled "Messila Park, New Mexico."

Coccus confusus newsteadi, Cockerell.

Pl. 1, figs. 5a-5g.

Coccus confusus subsp. *newsteadi*, Fernald, "A Catalogue of the Coccidae of the World," 1903, p. 82.

Coccus tomentosus subsp. *newsteadi*, Ckll., Science, 1898, n.s., viii, p. 675. Bull. 32, Ariz. Exper. Stat., 1899, p. 284.

Of this species, Prof. Cockerell writes (Science, *loc. cit.*):—

"The sub-species *newsteadi* was first described by Mr. R. Newstead in the *Entomologist's Monthly Magazine*, April, 1897, pp. 75, 76, from specimens imported to Kew Gardens on *Opuntia fulgida* from Arizona. He intended at first to name it as distinct, but finally treated it as *tomentosus*. It is a fair intermediate between *tomentosus* and *confusus*, both structurally and geographically. It has the spines and glands about as in *tomentosus*, but averages smaller, with the antennae usually 6-segmented, and the cottony secretion abundant, much as in *confusus*. It occurs in Walnut Creek Cañon, near Flagstaff, Arizona (Ehrhorn), La Puerta Rancho, in Tamaulipas (Townsend), Point Isabel, Texas (Townsend)."

From this it would appear that Cockerell at first considered *newsteadi* to be a sub-species of *tomentosus*. Mrs. Fernald catalogues it as *confusus* subsp. *newsteadi*, presumably on the strength of a later paper by Cockerell (Bull. 32, Ariz. Exp. Sta.) which I have not had an opportunity of consulting. Moreover, Cockerell connects the name with examples of *tomentosus* from Kew Gardens. If my examples from Arizona (ex coll. Ehrhorn) are typical of Cockerell's sub-species, they are sufficiently distinct from Newstead's *tomentosus*. The following description is drawn up from these Arizona examples.

Adult female densely covered with mealy secretion: broadly oval, proportionately narrower than typical *confusus*.

Eyes (fig. 5—a) moderately prominent; not densely chitinous.

Antennae (fig. 5—b) small; basal joint very broad; 2nd joint in the form of a shallow chitinous ring; 3rd and 4th joints cylindrical, length approximately equal to breadth; 5th and 6th much shorter than broad; 7th elongate oval, rather narrow. Total length of antennae 0.18 mm. Breadth of basal joint 0.068 mm.

Legs (figs. 5—c, d, e) small, moderately stout: femur and

trochanter together 0.21 to 0.22 mm.; tibia 0.08 to 0.1 mm.; tarsus (without claw) 0.1 to 0.12 mm.

The dermal pores (fig. 5—f) and truncate spines (fig. 5—g) as in typical *confusus*; the clusters containing from 4 to 30 pores and averaging 13.

Length of body (under compression) from 2.5 to 3 mm. Breadth 1.5 to 2 mm. An average of six examples gives a dimension of 2.75 × 1.79 mm.

Distribution.—Arizona, Colorado, Texas.

Though much smaller in size than typical *confusus*, the antennae and limbs of *newsteadi* are both relatively and actually larger.

Coccus confusus capensis, nov.

Pl. 1, figs. 6a-6g.

Adult female profusely covered with white mealy secretion which more or less completely conceals the form of the individual insects. Broadly oval, usually narrowed behind.

Eyes (fig. 6—a) moderately prominent; not densely chitinous.

Antennae (fig. 6—b) small; basal joint very broad; 2nd joint ring-shaped; 3rd and 4th approximately equal and twice as broad as long; 5th and 6th smaller, broader than long; 7th irregularly ovate, longer than broad, tuberculate. Total length of antennae 0.15 to 0.17 mm. Breadth of basal joint 0.07 to 0.09 mm.

Legs (figs. 6—c, d, e) small, moderately stout; femur and trochanter together 0.2 to 0.23 mm.; tibia 0.08 to 0.12 mm.; tarsus (without claw) 0.1 to 0.12 mm.

Dermal pores (fig. 6—f) conspicuous, in dense clusters (especially towards posterior extremity); a few single pores and small scattered groups; largest groups with 30 pores; average 15.

Truncate spines (fig. 6—g) numerous and conspicuous; stout, cylindrical; proportionately shorter than in typical *confusus* or *newsteadi*; diameter of base usually much more than half the total length of spine.

Length of body (under compression) from 2.5 to 3.5 mm. Breadth 2 to 2.75 mm. An average of sixteen examples gives a dimension of 3 × 2.27 mm.

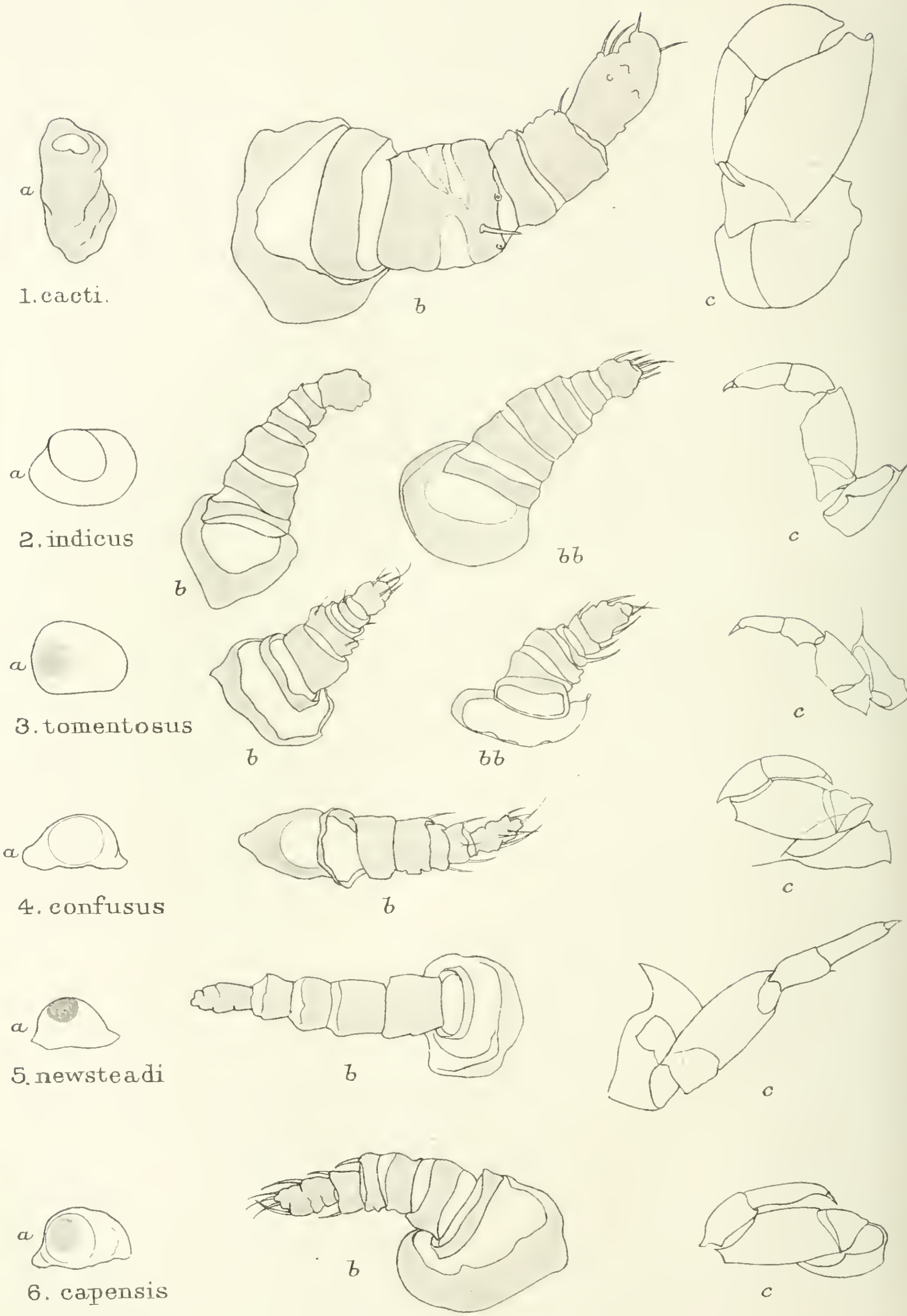
Distribution.—Cape Colony, South Africa.

The origin of this form is obscure. Mr. Lounsbury informs me that the wild cochineal is found only upon the wild Prickly Pear (*Opuntia monacantha*), in Africa.

This form differs from typical *confusus* in its smaller size and in the relatively stouter spines.

Tabular Statement showing comparative dimensions (in millimeters) and other characters.

	Length of body.	Breadth of body.	Average dimensions.	Length of antenna.	Diam. of joint basal.	Length of femur and trochanter.	Length of tibia.	Length of tarsus.	Number of pores in Clusters.	Average Number of pores.
cacti	4—6	3—4.5	4.75 × 3.87	0.2—0.3	0.16	0.38	0.16	0.15	2—25	13
indicus	1.75—5	2—4	3.44 × 2.75	0.12—0.16	0.07	0.16—0.2	0.06—0.09	0.08—0.1	3—6	4
tomentosus	2—3	1.5—2.5	2.5 × 2	0.1—0.11	0.07	0.12—0.16	0.06—0.07	0.06—0.08	2—16	6
confusus	3.5—4.75	2.75—4	4.11 × 3.52	0.16	0.07	0.18—0.21	0.08	0.09—0.12	3—36	15
newsteadi	2.5—3	1.5—2	2.75 × 1.79	0.18	0.06	0.21—0.22	0.08—0.1	0.1—0.12	4—30	13
capensis	2.5—3.5	2—2.75	3 × 2.27	0.15—0.17	0.08	0.2—0.23	0.08—0.11	0.1—0.12	4—30	15



E. E. Green del. ad nat.

COCHIN

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From this statement it is seen that—in all the measurements—*cacti* is the largest and *tomentosus* the smallest of the several forms; *indicus* is well marked by the small number of pores in the clusters; while *confusus, newsteadi,* and *capensis* have very large clusters.

EXPLANATION OF PLATE I.

Illustrating Mr. E. Ernest Green's paper "On the Cultivated and Wild Forms of Cochineal Insects."

1. *Coccus cacti*, auct.
2. *Coccus indicus*, Green.
3. *Coccus tomentosus*, Lam.
4. *Coccus confusus*, Ckll.
5. *Coccus confusus newsteadi*, Ckll.
6. *Coccus confusus capensis*, Green.

(Lettering the same for all the figures).

a.	Eye, - - - -	× 250
b.	Antenna, - - -	× 250
c.	Front leg, - - -	× 100
d.	Mid leg, - - -	× 100
e.	Hind leg, - - -	× 100
f.	Dermal pores, - -	× 450
g.	Truncate spines, - -	× 450

THE APHIDES ATTACKING *RIBES*, WITH DESCRIPTIONS OF TWO NEW SPECIES.

By

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With Plates II and III and 14 Figures.

Contents.

The Aphides attacking Ribes.

Until recently only four species of Aphides have been referred to in this country as attacking the cultivated and wild Currants and Gooseberries (*Ribes spp.*).

The previously recorded species are *Rhopalosiphum lactucae,* Kaltenbach; *Myzus ribis,* Linnaeus; *Macrosiphum lactucae,* Schrank, and *Schizoneura ulmi,* Linnaeus.

Of these *Macrosiphum lactucae,* Schrank, is undoubtedly the same as *Aphis ribicola,* Kaltenbach, which is a true Macrosiphum.

One of the commonest and by far the most destructive species has not been recorded as British, namely *Aphis grossulariae,* Kaltenbach. To this list I must add a very marked and beautiful new Rhopalosiphum which I have named after its discoverer, Mr. Britten, of Lalkeld Dykes, Penrith.

The other new species is a small Myzus, allied to *Myzus ribis,* but very distinct, and which I here describe under the name of *whitei,* in honour of Mr. E. A. White, of Beltring, Kent, who first discovered it.

I have two other species, both undoubtedly new, but as there are no alate forms they cannot be described.

Damage caused by Ribes Aphides.

The Ribes feeding Aphides frequently cause very serious loss to fruit growers all over Britain, and three species at least are extremely difficult to deal with, spraying being quite useless against them.

Damage is caused to the foliage by *Rhopalosiphum lactucae* and *R. brittenii*, the insects affecting the lower sides of the leaves

Fig. 1.—Damage to currants caused by *Aphis grossulariae*, Kalt.

at the top of the shoots (Fig. 7), which become curled and bent, and these may even become so dense that the "apterae" feed on the shoots and produce a certain amount of contortion (Fig. 2), but this as far as I have observed is unusual. The Macrosiphum, *M. lactucae* lives in a similar way, but does not seem to do so much

damage. Shoots attacked by these three species may afterwards grow out all right (Fig. 2).

Myzus ribis is mainly found on the under-sides of the larger leaves living in the concavities of red, yellow or green blisters. This galled appearance of the leaves (Fig. 11) seen on all varieties of red, white and black currants is I am sure not due entirely, if at all, to

Fig. 2.—Contortion of currant shoot due to *Rhopalosiphum lactucae*, etc., which later has grown away.

the Aphides, for I have year after year found these swellings on young leaves where no Aphis has been present. Too many have been examined for any other opinion to be formed. Later, however, the shelter of these concavities on the under-sides of the leaves affords ample and convivial ground for the Myzus to live and breed on.

The attack of the Myzus is not as a rule serious, as the growing points are not attacked to any great extent, and they never seem to touch the wood.

Rhopalosiphum lactucae also occurs under the red blisters on the leaves.

Aphis grossulariae, Kaltenbach, is by far the most harmful species; it lives in dense colonies on the tender young leaves and on the top of the shoots, causing the shoots to cease growing, and the leaves to curl downwards; the result is a dense tangled apical mass (Figs. 1 and 4), often so compact that one has to tear the leaves off to see the dark green aphides hidden beneath. This species attacks all currants and the gooseberry, and often so checks the growth that the bushes are ruined. The small swollen, stunted and contorted shoots are most marked.

Schizoneura ulmi, Linnaeus, lives on the roots of all currants and also on gooseberries as the so-called *Schizoneura fodiens* of Buckton; in young stock it causes a good deal of damage, damage which is frequently put down to other causes, owing to the insect not being seen except when stock is being removed in late autumn or early winter. The leaf feeding form on the elm causes the leaves to curl up in characteristic manner (Fig. 14).

The Bionomics of Ribes Aphides.

As far as is known at present there is no Aphid which passes the whole of its life-cycle on currants or gooseberries. There is yet much to learn in this matter.

A bad blight on these cultivated fruits may go suddenly, or it may pass away gradually, but it is not until a varying amount of damage has been done that the insects disappear from the Ribes.

We now know that *Rhopalosiphum ribis*, Buckton (non Linnaeus) flies to lettuce in summer and becomes Kaltenbach's *Rhopalosiphum lactucae* on garden lettuces, on sow-thistles (*Sonchus*), on *Cichonium endivum, Lapsana vulgaris*, and according to Buckton it occurs on *Picris hieracioides*. We know also the Schizoneura called *fodiens* of Buckton flies to the elm and causes the leaf curling due to *Schizoneura ulmi* of Linnaeus.

I have recently followed a migration of *Macrosiphum ribicola*, Kaltenbach, to lettuce and sow-thistle, where it becomes the *Macrosiphum lactucae* of Kaltenbach.

What happens to *Myzus ribis*, which is one of the last to stay on the currants, I have failed to trace. It has gone by August, and I have never seen it again until the middle of May.

Again, with the pernicious *Aphis grossulariae* of Kaltenbach

we can say as yet nothing definite. But I cannot at present find any structural difference between it and the species Buckton describes as *Aphis viburni*, Schrank, the very marked spinose nature of the two, their time of disappearance from *Viburnum opulus* and appearance on the Ribes makes it seem that they may be the same, in spite of the fact that I have twice failed to plant winged *grossulariae* on Viburnum.

With regard to *R. brittenii* the matter should soon be solved owing to the very marked form of this insect, which so far has only been sent me from the North of England.

Parasites and Enemies.

Probably no insects are more prone to parasitic attack than the Aphididae. Of those attacking the currant and gooseberry *Myzus ribis* seems to be their best breeding ground. Last year, a notable Aphis year, I found, by keeping many red currant leaves in mouse jars, that 90 per cent. of this Aphis were parasitised by hymenopterous enemies in my own garden and two neighbouring farms. These parasites did not make themselves noticeable until the beginning of July, when the damage had all been done, and yet in spite of this drastic attack *Myzus ribis* was worse this year than I have ever seen it.

Rhopalosiphum lactucae is also attacked by Braconidae and Chalcididae to some extent, and so is *Aphis grossulariae*, but never to the same extent as the Myzus. Syrphidae and Coccinellidae are extremely rare it seems on the "Ribes" Aphides. I have only once found Coccinellidae attacking any Ribes species, and have had their larvae sent me once from Wisbech and once from Exeter with *Rhopalosiphum*. Syrphidae occur here and there, but as far as the Ribes Aphides go they are a negligible quantity as enemies. Whilst sparrows, whitethroats, willow wrens, and starlings will eat apple, plum, bean, pea, and other Aphides, they seem to avoid those on the bush fruits.

A small predacious Red Mite (*Anystis cornigera*, Koch.), I have frequently seen in the colonies of *Aphis grossulariae*, which undoubtedly feed on them—but in such small numbers that they make no appreciable effect.

Table of Ribes feeding Aphides.

A. Cornicles cylindrical, rather short and thick; antennae shorter than body; Abdomen tuberculate; Green to dark green; cornicles pale ... ... 1. *Aphis grossulariae*, Kaltenbach.

B. Cornicles long and cylindrical; antennae longer than body; cornicles black; sensoria on antennal segments 3 and 4 ... 2. *Macrosiphum lactucae*, Schrank.

C. Cornicles swollen.

Cornicles pale and moderately swollen; sensoria on segments 3, 4 and 5 of alate female. ... 3. *Rhopalosiphum lactucae*, Kaltenbach.

Cornicles black, much swollen; sensoria on segments 3 and 4 only in alate female ... ... 4. *Rhopalosiphum brittenii*, nov. sp.

D. Cornicles very thin with traces of slight swelling apically; head and body hairs markedly capitate; alate female with sensoria on segments 3 4 and 5 of antennae, on whole length of the latter ... 5. *Myzus ribis*, Linnaeus.

Antennal segments 3, 4 and 5 with sensoria, but only on basal half of 5. Third segment with about 40 sensoria ... ... 6. *Myzus whitei*, nov. sp.

E. Cornicles absent, antennae very short ... ... 7. *Schizoneura ulmi*, Linnaeus.

Aphis grossulariae, Kaltenbach.

Pl. ii, fig. 3.

Aphis viburni, Schrank ?

Mono. d. Fam. d. Pflanzenlaüse, p. 67, 1843, Kaltenbach; Fauna Boica, II, III, 1203, Schrank.

Alate viviparous female.—Head and thorax blackish; traces in some specimens of a green band on the pronotum. Abdomen deep greenish-yellow to dark green, some specimens showing faint lighter lines running from one end of the abdomen to the other; abdomen with four prominent blunt lateral tubercles and traces of one or two more close together near the apex. Antennae (Fig. 3, A) much

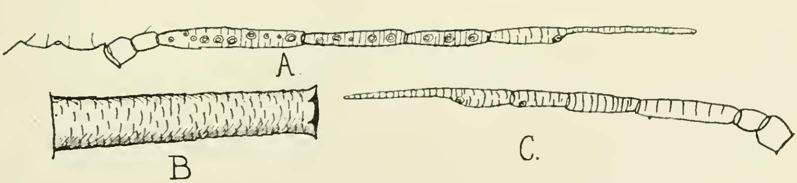

Fig. 3.—*Aphis grossulariae*, Kaltenbach. A, Antenna of alate female. B, Cornicle of alate female. C, Antenna of nymph.

shorter than the body, black, the third segment with 8-12 sensoria, the fourth with 5-7 sensoria, and the fifth with 3-4 sensoria, all these segments striated. Cornicles (B) greenish-yellow, imbricated, somewhat darker at the base. Legs dark green, apices of femora, tibiae and the tarsi darkened. Cauda yellowish-green to green. Wings of a yellowish tinge at the base, stigma grey.

Apterous viviparous female.—Deep bright green to dark green; abdomen with seven pairs of blunt lateral tubercles, two pairs between the cornicles and the cauda. Cornicles and cauda pale, apex of former dusky. Antennae green, last two segments dusky, no sensoria. Legs paler green than the body, femora rather swollen, dusky at apex, also the tibiae and the tarsi all dark.

Bionomics.—This Aphis is found from the middle or end of May until July on the gooseberry and red and black currants. It appears, as far as I have been able to trace, as a winged female in May and June, and goes on breeding until the middle of July, and in one case I found them late in the month. In the end of June and onwards winged females become prevalent, and gradually they leave the Ribes, and, as far as I have observed, do not appear until the following year.

Kaltenbach refers to them on the gooseberry in June and July, and in August on the black currant. Koch refers to winged and wingless females in the end of May.

The Aphis I have found on the Guelder Rose seems very similar and they left (as winged Aphis) the Guelder Rose early in June. The winged females agreed with those on the gooseberry and currants, and in August and September Aphis appeared again on the Guelder Rose, and in October these laid eggs. The sexual forms on the Viburna are common, but as I have not been able to demonstrate any definite migration I merely point out here that *Aphis viburni*, Schrank, may be the alternating form. In any case, *A. grossulariae*, Kalt., does not seem to winter on the Ribes.

Damage done.—The damage caused by this Aphis is very serious; it causes a dense clustering of the apical leaves, and so distorts the shoot that growth is practically stopped. They soon settle on the young wood and check its growth, the result is that the leaves grow out close together, and then, as they cluster under them, they turn down in a dense overlapping mass (Figs. 1 and 4), which prevents any wash or the finest spray from reaching them.

Distribution.—Kent, at Wye, Ashford, Marden, Canterbury, Faversham, Sellindge, Hythe, Appledore, Swanley, Chelsfield, Maidstone, Tenterden, Tonbridge, Yalding, Ash. Sussex at Hail-

sham, Hastings and Rye. Surrey at Bramley, Guildford, Kingston-upon-Thames and Esher. Cambridgeshire at Haddenham and Wisbech. Essex at Widdington and Colchester; and at Penrith in Cumberland.

Fig. 4.—Damage caused to a gooseberry shoot by *Aphis grossulariae*, Kaltenbach.

Observations.—This is quite one of the worst Ribes Aphides, as it is impossible to deal with it by spraying. It is undoubtedly described by Kaltenbach under the name adopted here, and is figured by Koch, the marked abdominal tubercles at once separating it from all other Ribes Aphides.

Macrosiphum lactucae, Schrank.

Pl. iii, fig. 1.

Aphis lactucae, Schrank.
Aphis ribicola, Kaltenbach.
Siphonophora ribicola, Koch.
Siphonophora lactucae, Buckton, Passerini (non Koch).
Aphis ribis, Frisch.

Mono. d. Fam Pflanzenlaüse, 33, 1843, Kaltenbach; Die Pflanzenlaüse Aphiden, 195. 1857, Koch; Mono. Brit. Aphides, I, 139, 1867, Buckton; Gli Aphidi, 34. 1860, Passerini.

Alate viviparous female (on *Ribes*).—Thorax shining black, with a green line on each side, spreading out posteriorly; pronotum green, with two black spots.

Head green, darkened in front with two dark round spots; eyes dark red to black; antennae (Fig. 5, A) dark, longer than the body, the third segment with 30-40 sensoria spreading over its whole length, fourth segment with 7-14 sensoria, mainly along one side, faintly striate, some of the hairs slightly capitate. Abdomen shiny green to yellowish-green, the second, third, and fourth segments with two dark brown to black basal patches, the fifth and sixth each with two smaller patches closer together, and in some there are dark marks further back; laterally there are three large black spots and sometimes traces of a small fourth one basally. Cornicles (Fig. 5, B)

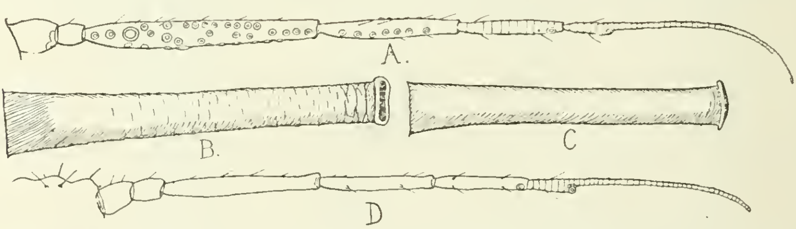

Fig. 5.—*Macrosiphum lactucae* (*Ribes* form). *a*, Antenna of alate female. *b*, Cornicle. *c*, Cornicle of nymph. *d*, Antenna of nymph.

long, thin, cylindrical, black, often becoming paler apically; reticulate at apex, remainder imbricated; cauda moderately long, blunt, dark brown. Wings with yellowish-brown to brown stigma.

Legs green to yellowish-green, apical half of femora, apex of tibiae and the tarsi dark, femora and tibiae bristly.

Apterous viviparous female (on *Ribes*).—Green, shiny; eyes red; antennae green; apices of fourth and fifth segments dusky, the sixth dusky, especially at the base and apex. On the abdomen are traces of five to seven slightly darker lateral spots; cornicles long, yellow, slightly dusky at the apices, reticulated at apex, rest faintly imbricated. Legs yellowish-green, tarsi dark.

The *nymph* resembles the apterous female, but the cornicles do not seem to show any ornamentation.

Second alate female (on lettuce, etc.).—Head and thorax dark brown to black, shiny; eyes dark reddish; antennae (Fig. 6, A) dark brown, longer than the body, the second segment with 22-39 sensoria spreading over the whole surface, fourth segment with 11 to 14 sensoria: fifth without sensoria except for the usual sub-apical one; hairs slightly knobbed.

Abdomen green with five to seven irregular broken dark bands and four large dark spots on each side; apex of abdomen and cauda dusky. Cornicles (Fig. 6, B) dark brown, pale and reticulate apically, imbricated, long, very slightly swollen now and again towards the apex. Legs ochre yellow, apical half of femora, apex of the tibiae and all the tarsi dark. Wings yellowish at the base, stigma brown.

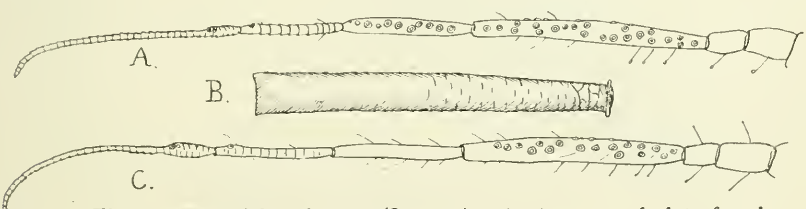

Fig. 6.—*Macrosiphum lactucae* (Lettuce). A, Antenna of alate female. B, Cornicle of apterous female. C, Antenna of apterous female.

Apterous viviparous female (on lettuce, etc.).—Yellowish-green to bright green. (Buckton describes some specimens as more or less clouded with pink). Abdomen with seven pairs of dark lateral spots, wrinkled and shiny.

Antennae (Fig. 6, C) longer than body, the third segment with 20 to 25 sensoria, most numerous on the basal half, decreasing towards the tip; basal segment dusky, second, third, fourth, and fifth pale green, apices of third, fourth, and fifth dusky, sixth dusky, but paler in the middle, hairs minutely capitate; there are also capitate hairs on the body and several on the vertex of the head; cauda yellowish; cornicles (Fig. 6, C) yellowish, dusky at the apices, which are markedly reticulated, the rest faintly imbricated.

Legs yellowish-green to green, apices of femora dusky, a broad apical dark band to the tibiae and dark tarsi; femora and tibiae spinose.

The *nymph* is like the apterous female, but has paler antennae and dusky tipped wing-cases. Cornicles not showing any ornamentation.

Distribution.—Kent (Wye, Paddock Wood, Yalding, Tunbridge Wells, Chelsfield, Bearsted, Swanley, etc.); Sussex (Worthing and Coleman's Hatch); Cambridge; Great Lalkeld, Penrith, Cumberland; Great Staughton, Hunts; Widdington, Essex. Buckton gives no localities.

Bionomics.—I have found this species on red and black currants in the autumn, but failed to obtain any sexed forms. It occurs on the Ribes up to the first week in June, and a few stragglers until

Fig. 7.—Damage caused to currants by *Macrosiphum lactucae*, Schrank and *Rhopalosiphum lactucae*, Kaltenbach.

the end of the month in some years. It then appears to fly off and settles on lettuces, endives, sow-thistles and *Crepis*, and is frequently very harmful to the two former, where it goes on breeding until the autumn, and then leaves the annuals and *Sonchus*, and a similar form is found on the currants, where presumably it oviposits. It causes the leaves to curl slightly (Fig. 7), but I have not found it to distort the shoots to the same extent as *A. grossulariae*. It does not seem to breed rapidly on the currants, and does little harm, as far

as I have been able to trace. In lettuces it breeds most rapidly, and causes great annoyance. I can see no structural differences between the lettuce and currant forms and their periods of arrival and dispersal between the plants coincide.

Observations.—Buckton (Pl. xvi, Fig. 5) figures the alate viviparous female of *lactucae* with black cornicles; this is what I have always seen, but in his description he says, "Cornicles green with black tip." He also records *lactucae*, Kalt., from *Ribes grossularia* and *Ribes nigrum*.

Kaltenbach refers to his *ribicola* as occurring on the mountain currant at the end of May, and on *Crepis viridis* later.

Buckton refers to *lactucae* having pink varieties amongst the apterous viviparous females, and the pupae as also being green, brown or pink, the pink varieties having often a green dorsal band and faint lateral stripes. Now and again I have found these variations on the lettuce, but only once a few pink forms on the currant.

Rhopalosiphum lactucae, Kaltenbach.

Pl. iii, fig. 2.

Aphis lactucae, Kaltenbach.
Rhopalosiphum ribis, Buckton (non Linnaeus).
Rhopalosiphum lactucae, Buckton.
Rhopalosiphum lactucae, Passerini.

Mono. d. Fam. d. Pflanzenlaüse, 37, 1843, Kaltenbach; Mono. Brit. Aphides, II, 9, 10, Buckton.

Alate viviparous female (on Lettuce).—Head and thorax deep shiny brown to black; prothorax yellowish-green and black. Abdomen yellowish-green to green, with an irregular dark broken area on the posterior half, two pairs of smaller dark spots in front, and three large and one small dark lateral spots, a large dark patch at the base of the cornicles; cauda pale yellow; cornicles (Fig. 8, B) swollen, yellow, slightly dusky at their apices, which are reticulated,

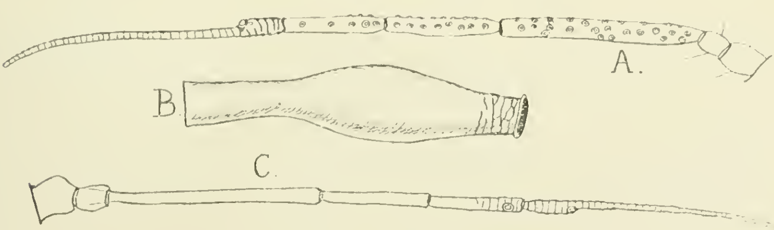

Fig. 8.—*Rhopalosiphum lactucae*, Kaltenbach. A, Antenna of alate female (currant form). B, Cornicle of alate female. C, Antenna of apterous female.

no trace of ornamentation below. Antennae (A) dark brown to black, the third segment with many sensoria (25-35), the fourth with 17-20 sensoria, the fifth with a few sensoria, mostly basal.

Legs yellowish-green, apices of femora and tibiae dark, also the tarsi; femora and tibiae, especially the latter, with fine short hairs. Wings with yellowish-brown stigma.

Apterous viviparous female.—Green to yellowish-green, shiny. Antennae (C) green, apices of the segments dusky; cauda green; cornicles green, reticulated at apices; eyes red. Legs yellowish-green, tarsi dusky, and to some extent the apices of the femora and tibiae.

Alate viviparous female (on *Ribes*).—Similar to the first, but the dark abdominal area is not quite so large in some specimens, and there are traces on the first two to four segments of submedian dark spots.

Apterous viviparous female.—Green, somewhat deeper coloured than when on the lettuce.

Nymph.—All green and yellowish-green, the head and thorax often darker than abdomen, wing-cases green.

Distribution.—Widely spread over Britain from North to South. Specimens received from or found in Kent, Surrey, Sussex, Hampshire, Devon, Cornwall, Essex, Middlesex, Cambridgeshire, Yorkshire, Cheshire, Lancashire and Cumberland.

Bionomics.—This Aphis as *Rhopalosiphum ribis* (Buckton), winters in the egg stage on the red and black currant, especially the former, and sometimes on the gooseberry. It often lives under the leaves in the red blistered areas (Fig. 11), which also shelter *Myzus ribis*. In April they have some years increased to such an extent that the hosts of apterous females do a lot of damage, they then cluster on the top shoots and cause a loose tuft of leaves (Fig. 7), just as *M. lactucae* does, not a compact tuft, as produced by *Aphis grossulariae* (Fig. 4). During May winged females appear; the earliest note I have is May 3rd, the latest June 27th. These winged females fly off to lettuces and sow-thistles, to *Lapsana vulgaris, Picris hieracioides* and other plants, where they breed through June, July and August, and in September and October fly back to the currants.

Frequent winged broods of *lactucae* occur and spread from lettuce to lettuce and to other plants.

Observations.—Buckton treats *Rhopalosiphum lactucae*, Kaltenbach, and *Rhopalosiphum ribis*, Linnaeus, as two distinct species; the latter is not Linnaeus' *Aphis ribis*, which is *Myzus ribis*.

Schouteden points out that Buckton's *R. ribis* is distinct, and the same as Kaltenbach's *A. lactucae*, in which I quite agree. Buckton also records his *R. ribis* from the Guelder Rose, *Viburnum vulgaris*.

Kaltenbach records *lactucae* from *Sonchus oleraceus*, *asper* and *arvensis*, Schouteden from *S. oleraceus*, *Cichorium endiva* and *Ribes* sp. in Belgium.

Rhopalosiphum brittenii, nov. sp.

Pl. ii, fig. 2.

Apterous viviparous female.—Head yellow to dull orange yellow, with a black median area. Antennae black, except the base of the third segment; not as long as the body. Thorax black, with a narrow median yellowish-green transverse line.

Abdomen yellowish-green to bright pale green, with a large, median squarish black dorsal area, a small laterally elongated one in front and a still smaller one behind it, four large black lateral spots, another at the base of the cornicles and between them and the median area 6-8 small black specks and a pair between the two cornicles; a more or less straight and then a curved black band posteriorly; cauda black. There is some variation in the markings.

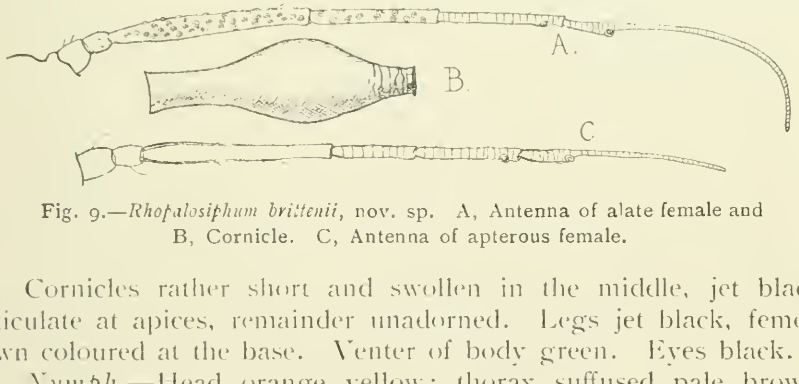

Fig. 9.—*Rhopalosiphum brittenii*, nov. sp. A, Antenna of alate female and B, Cornicle. C, Antenna of apterous female.

Cornicles rather short and swollen in the middle, jet black, reticulate at apices, remainder unadorned. Legs jet black, femora fawn coloured at the base. Venter of body green. Eyes black.

Nymph.—Head orange yellow; thorax suffused pale brown; body green with a few dark specks; cauda black; cornicles greenish-black. Antennae all dark, legs as in female, but paler. Wing-cases almost black.

Alate viviparous female.—Head dark brown; pronotum dark brown with a narrow yellow anterior band; thorax dark brown, yellow in front and at the sides. Abdomen pale yellowish to yellowish-green with dark irregular transverse bars, the first two or three narrow, the next broad, then two small ones, three large dark lateral spots, then one small one, a large dark patch at the base of the cornicles; cauda pointed, dusky, almost black; cornicles (Fig. 9, B)

jet black, large, much swollen, not reaching as far as the tip of the cauda, reticulate at apices. Antennae (Fig. 9, A) black, about the same length as the body, the third segment with from 40 to 43 sensoria, the fourth with from 12 to 20 sensoria over the whole of their length, none on the fifth, the fifth and sixth striated. Legs dark brown to black, the femora pale on their basal half, wings with faint yellowish-brown stigma.

Length—Body, 2.5 to 3 mm.; wing expanse, 4 to 4.5 mm.

Distribution.—Great Lalkeld, Penrith.

Observations.—This very marked and beautiful species was found by Mr. Britten, after whom it is named. Apterous females and larvae were sent me on May 4th and May 16th; the latter consignment contained one nymph. In the middle of June winged females arrived, and on June 29th a further consignment was examined. Mr. Britten says that it is commonest on red currants, fairly common on black, and the same on gooseberry.

This aphis curls the young leaves, and Mr. Britten was unable to detect any difference in the damage done from other leaf-curling species on Ribes.

I have had collections sent from most parts of England, many places in Ireland, and several in Wales, and have not been able to hear of it elsewhere.

It comes owing to its large cornicles near *Rhopalosiphum calthae*, Koch, and a new black species like *calthae* I have from Willows sent me by the Board of Agriculture. I have retained these three in the genus *Rhopalosiphum* in spite of the fact that they are quite distinct from all other aphides placed in this genus, which merges into Aphis on the one side and Macrosiphum on the other.

Types in the writer's collection.

Myzus ribis, Linneaus.

Pl. iii, fig. 3.

Aphis ribis, Linnaeus, Kaltenbach.
Rhopalosiphum ribis, Koch.
Myzus ribis, Passerini ?

Syst. Nat., II, 733, 1, Linnaeus; Mono. d. Fam. d. Pflanzenlaüse, 39, Kaltenbach; Die Pflanzenlaüse, 39, Koch.

Alate viviparous female.—Pale greenish-yellow to pale yellow; head darker yellow to olive, with two dark round spots; eyes red, hairs markedly capitate; antennae (Fig. 10, A) dark, two basal segments yellowish, with capitate hairs, third, fourth, and fifth

segments with sensoria, the third with 25-30, fourth with 15-22, fifth with 9-11, extending the whole length of the segment.

Thorax with brown lobes, now and then a dark area on the pronotum.

Abdomen with dark, median broad bands on the fifth to seventh segments, and with four dark spots on each side; hairs capitate; cornicles (Fig. 10, C) thin, swelling in some specimens to some extent apically, yellow to very pale brown, a faint line or two at their apices; cauda yellow. Legs pale yellowish-brown, with dusky apices to femora and tibiae and dusky tarsi. Wings with yellow insertions, dusky veins and stigma.

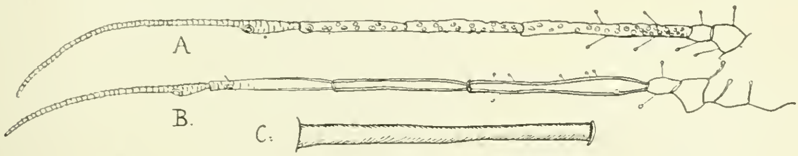

Fig. 10.—*Myzus ribis*, Linn. A, Alate female. B, Apterous female antenna. C, Cornicle of alate female.

Apterous viviparous female.—Yellowish-green to pale yellow, now and then with darker green mottlings, with capitate hairs. Eyes red; antennae (Fig. 10, B) pale yellowish-green to almost transparent, longer than body and thin, third segment with five capitate hairs on one side, one on the other. Cauda pale semi-transparent yellow. Legs pale yellow with dark tarsi, hairy, hairs capitate.

Distribution.—I have received or found this species in many places in Kent, Surrey, Sussex, Middlesex, Cambridgeshire and Essex, and from Great Lalkeld, Penrith; Widdington, Essex; many places in Devon and Somerset. It is probably widely spread over the British Isles. It also occurs in America, Gillette recording it from Chicago, and Webster from Massachusetts, and that is is fairly common about Fort Collins and Denver (*Journal Econ. Entom.*, vol. 4, p. 382).

Life-cycle.—This is unknown. I have found wingless females on red and black currants by Mid-May, and they continue into July, when they begin to decrease, and by the end of the month most have flown, but some apterae continue to the end of August. Winged females commence to appear towards the end of June, and go on until the beginning of August. I have always failed to trace where they fly to.

Observations.—Koch undoubtedly describes this insect under the name *Rhopalosiphum ribis*. Buckton figures a winged female

of *Macrosiphum ribicola* with black cornicles as this insect; the cornicles are never black in *M. ribis*, and the abdominal ornamentation is very distinct. Buckton also gives as a food plant gooseberry, and so does Kaltenbach. It is most abundant on red currants, and swarms under the red blisters on the leaves, which they

Fig. 11.—Currant foliage blistered by *Myzus ribis*, Linnaeus.

are said to produce (Fig. 11). The larvae and young apterous females are often almost glass-like. I have never found this species except under the red blisters.

I do not think that this is a Passerini's *Myzus ribis*, for he makes no mention of the capitate hairs.

Myzus whitei, nov. sp.

Pl. iii, fig. 6.

Alate viviparous female.—Pale yellowish-green, head slightly dusky; thorax dark brown in the middle; abdomen with a large dark central patch, with two dark lateral spots in front. Antennae (Fig. 12, A) longer than body, dark brown; third and fourth segments

with sensoria all over them, the third with about 40 sensoria, fifth segment with a row of 3 to 7 sensoria on basal half only, hairs capitate; eyes dark; cornicles long (Fig. 12, C), thin and delicate, slightly dusky, no signs of any ornamentation, slightly swollen apically; cauda pale, semi-transparent. Legs pale yellowish, long and thin, the apices of the femora and tibiae dusky, tarsi dusky, femora and tibiae hirsute, especially the latter. A few capitate hairs at the sides of the abdomen.

Food Plants.—Black currants, and once on gooseberries.

Habitat.—Paddock Wood and Wye.

Length.—Body, 2 mm.; wing expanse, 4 mm.

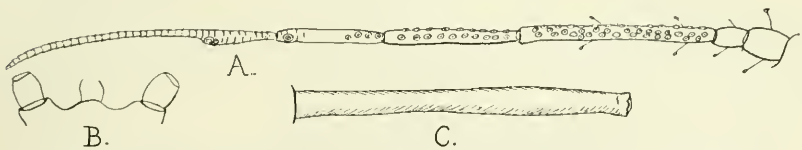

Fig. 12.—*Myzus whitei*, nov. sp. A, Alate female antenna. B, Head. C, Cornicle.

Observations.—This marked species was sent to me by Mr. White, of Beltring, Paddock Wood, in June of this year (1912). They were in company with *Rhopalosiphum lactucae*. Only alate forms were sent, and a few others were found in my garden during the same month. It is a small fragile species, easily told by the fifth segment of the antennae having sensoria only on its basal half, and by the marked dark dorsal patch on the abdomen. This description is drawn up from a few field notes and balsam preparations. It might be mistaken for *Myzus ribis*, but it is darker, and the sensoria of the fifth antennal segment only occur on the basal half, and the abdominal markings are distinctive.

Type in the writer's collection.

Schizoneura ulmi, Linnaeus.

Pl. iii, fig. 5.

Aphis ulmi, Linnaeus,
Aphis foliorum. DeGeer.
Schizoneura grossulariae, Taschenberg.
Schizoneura ulmi, Kaltenbach.
Schizoneura fodiens, Buckton.

Syst. Nat., 2, 733, 2, Linnaeus; Faun. Suec., 976, Linnaeus; Ent. Syst., IV, 217, 36, Fabricius; Ins., 3, tab. 25, Reaumur; Uebers, III, 53, tab. 5, figs. 7-12, DeGeer; Mono. Pflanzenlaüse, 173, Kaltenbach; Pflanz. 262, Pl. xlvii, figs. 337-338, Koch; Mono. Brit. Aphides, 99-94, Pl. cviii, cixi, cvi, Buckton.

Alate viviparous female (on *Ulmus*).—Black; in some individuals the abdomen is paler, almost brown; at first the abdomen has many

white filaments, but by the time it has flown a short distance most have vanished. Antennae (Fig. 14, A) black, less than one-third the length of the body, first two segments swollen, third long with 7-9 complete rings and 6-10 incomplete ones, fourth segment small, with one complete and 2-3 half-rings; fifth nearly twice as long as the fourth, with 6-7 complete rings and 2-3 half-rings; apical segment small, but may be a little larger than the fourth. Wings with brown stigma and veins, with faint opalescence when fresh, later in some lights having a smoky appearance. Legs black, femora a little paler at the base, a few small hairs on the femora and tibiae.

Apterous viviparous female (on *Ulmus*).—Bright pale green to olive brown, with traces of mottling on each segment, four spots or pores from which much white flocculent matter is passed out. Head and antennae brown to dark brown. Legs short and dark brown. The antennae very short.

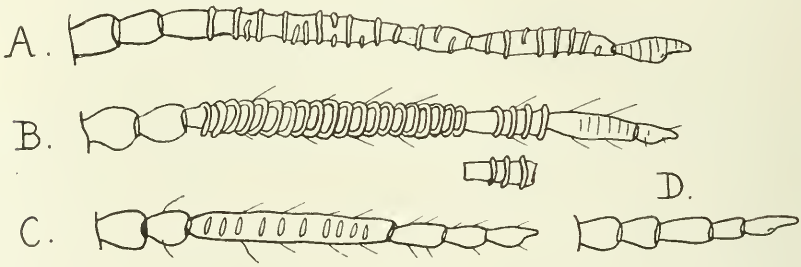

Fig. 13.—*Schizoneura ulmi* (Linnaeus) *fodiens*, Buckton. Antennae. A, Alate female of *S. ulmi*. B, Alate female of *S. fodiens*. C, Pupa, and D, Larva of *S. fodiens*.

Alate viviparous female (on *Ribes*).—Head and thorax black; abdomen slaty-grey to brown, in immature specimens pallid; antennae (B) short and black, the third segment long with about 20 annulations; the fourth short with three to four rings; the fifth about the same length as the fourth, simple; sixth, short; a few hairs on all segments. Legs black. Eyes reddish-brown, large. Cornicles represented by two dark rings.

Apterous viviparous female (on *Ribes*).—Varying from grey to rusty yellow, with darker head, mealy. Antennae dusky brown. Eyes very small. Legs dusky. Some specimens show a dusky spot on each side of the segments. Antennae simple, not annulated.

The *Nymph* is much the same colour as the apterous female, but is more elongate in form, the wing-cases brownish, thoracic lobes reddish-yellow; antennae short and thick, the third segment showing internal annulations; eyes black and reddish, of moderate size; body with prominent hairs.

Bionomics.—There are several points yet to be found out in the life-cycle of this insect. As far as is known the winter is passed on the elm in the egg stage. The eggs are laid in the late autumn, according to Buckton, in the crevices of the bark of such elm trees as have been infested during the past summer. They are small, dull yellow, or brownish ova, almost 0.05 mm. in length. They may or may not be covered with down and by the skin of the mother. Only one is laid by each female. I have found these ova on the twigs and axils of the buds, but never, as Buckton describes, on the bark. In May we find the "Mother Queen" under a leaf, and soon she commences to produce living young, as these by their

Fig. 14.—Elm leaves curled by *Schizoneura ulmi*, Linnaeus, which also attacks *Ribes* rootage as *S. fodiens*, Buckton.

punctures cause the leaves to curl downwards and become twisted and pale, sometimes almost white (Fig. 14). Under these curled leaves they breed, and amongst the colonies one finds much meal and wool and opaque round oil globules covered with fine white powder. In July the "apterae" become nymphae, and in July and August winged females appear and fly away. I have found these emigrating females on all manner of trees and plants. They readily take flight when disturbed, and settle with their wings held upwards, and move about with considerable rapidity. Some of these alate migrants settle on currants and gooseberries, and these make their way to the ground and produce their young on the nearest points they can

reach to the roots. These apterous young pass down to the roots and rootlets, and there they live and breed until November and even up to mid-December, when winged females (return migrants) appear and swarm from the ground, the nymphae having previously crawled upwards. I have, however, found alate forms actually in the soil, and in one case at Swanley as late as December 4th. The winged females are viviparous, and are Buckton's *Schizoneura fodiens*; they fly off to the elms and produce young, each of which appear at once to lay a single ovum. This is what I have followed on several occasions.

Buckton, quoting Lichtenstein, Couchet, Kessler and others regarding *S. ulmi*, gives no mention of his *S. fodiens* being the same. This was first discovered by Amyot.

According to Lichenstein, the fundatrix or mother (of *S. ulmi*) produces young which distort the leaves in spring on the elms. These, I have found, moult three times, and numerous young are produced of the second series. These undoubtedly wander to other leaves and produce a third generation, and these are said to become winged and spread over other trees. This I have failed to observe during the last fifteen years on the elms at Wye Court, where this Aphis abounds. This is the so-called "emigrante" stage of Lichtenstein. It probably refers to the winged summer forms that fly and partly live by settling and reproducing on the Ribes roots. Lichtenstein certainly pointed out that the produce of the "emigrante" females descend into the ground, but that they hibernated at the roots of grasses. Buckton records having sent him from Malden in Essex winged females from rolled elm leaves in October. These were so small, he says, that they might have been taken for another species; there is no doubt but that these were his *S. fodiens* returning to the elms, but much earlier than usually seems to take place.

Distribution.—I have only received the ribes form (*fodiens*) from Paddock Wood, Maidstone, Swanley and Faversham in Kent, and have found it at Wye. Specimens have also been sent to me from Farnham and Kingston-upon-Thames in Surrey, and from Hailsham in Sussex; Carpenter records it from Ireland. The elm form (*ulmi*) I have found in every district in England and Wales that I have visited where the elm occurs, and probably it and the subterranean race is widely distributed.

Damage.—The root form on currant and gooseberry under certain circumstances does a good deal of harm. It not only lives on the rootlets, but congregates on the larger roots and causes them

to split, and with young stock I have had complaints of it being seriously checked in growth. On elms the damage does not seem to be of any serious nature.

Prevention and Treatment.

In such cases as with the forms that go to the Ribes to oviposit a great deal of good may be done by autumnal spraying to kill the oviparous generation. I know of nothing that will destroy the ova of Aphides, and thus, if we can, it is well to kill the insects before they become sexually mature. I have found that by spraying in October (first week) with paraffin jelly the attack is much less next year of the species which winter on the Ribes. I have failed to find *Aphis grossulariae* doing so. Thus autumnal spraying will not check this insect.

With regards to spraying to kill the Aphis in spring, much depends on the aphis to be dealt with. *Myzus ribis* may speedily be cleared with soft soap and quassia, or tobacco wash, or paraffin emulsion. *Rhopalosiphum lactucae* and *M. whitei,* if taken in hand at once, may also be checked by the same method, but if once they are allowed to so increase that they curl the leaves, then spraying does but little good. The main thing with these three is to get the nozzles well under the bushes and give them a good washing. With *Aphis grossulariae*, when it has got the least hold, no spraying has any effect, for the leaves as shown in the photographs here are too densely packed to allow any wash to hit the dolphin. In this case all one can do is to send women round with tins of paraffin emulsion and dip each tip well into the tin. Prevention here is almost impossible. Another thing might serve in checking *Macrosiphum lactucae* and *Rhopalosiphum lactucae,* and that is to see that all lettuce near by or in the gardens, especially if running to seed, are destroyed before the end of September. It is certain we cannot stamp out the Schizoneura on the elms, but if a look out is kept in the summer for the winged migrants, then they may be kept off the currants and gooseberries by spreading a soil fumigant on the ground under the bushes. In two experiments I found that they would not enter the soil in which Vaporite had been spread and mixed.

No reliance whatever can be placed on natural enemies in Britain. The parasites appear too late to do any good, coming in their numbers when all the damage has been done, and the predacious insects do not give any relief of practical importance.

EXPLANATION OF PLATES II AND III.

Illustrating Professor Fred. V. Theobald's paper on "The Aphides attacking *Ribes*."

Plate II.

Alate viviparous females of:—

Fig. 1.—*Macrosiphum lactucae*, Schrank (from *Ribes*).
Fig. 2.—*Rhopalosiphum brittenii*, nov. sp.
Fig. 3.—*Aphis grossulariae*, Kaltenbach.

Plate III.

Alate viviparous females of:—

Fig. 1.—*Macrosiphum lactucae*, Schrank (from Lettuce).
Fig. 2.—*Rhopalosiphum lactucae*, Kaltenbach.
Fig. 3.—*Myzus ribis*, Linnaeus.
Fig. 4.—*Schizoneura ulmi*, Linnaeus (Elms).
Fig 5.—*Schizoneura ulmi*, Linnaeus (*fodiens*, Buckton). (*Ribes*).
Fig 6.—*Myzus whitei*, nov. sp.

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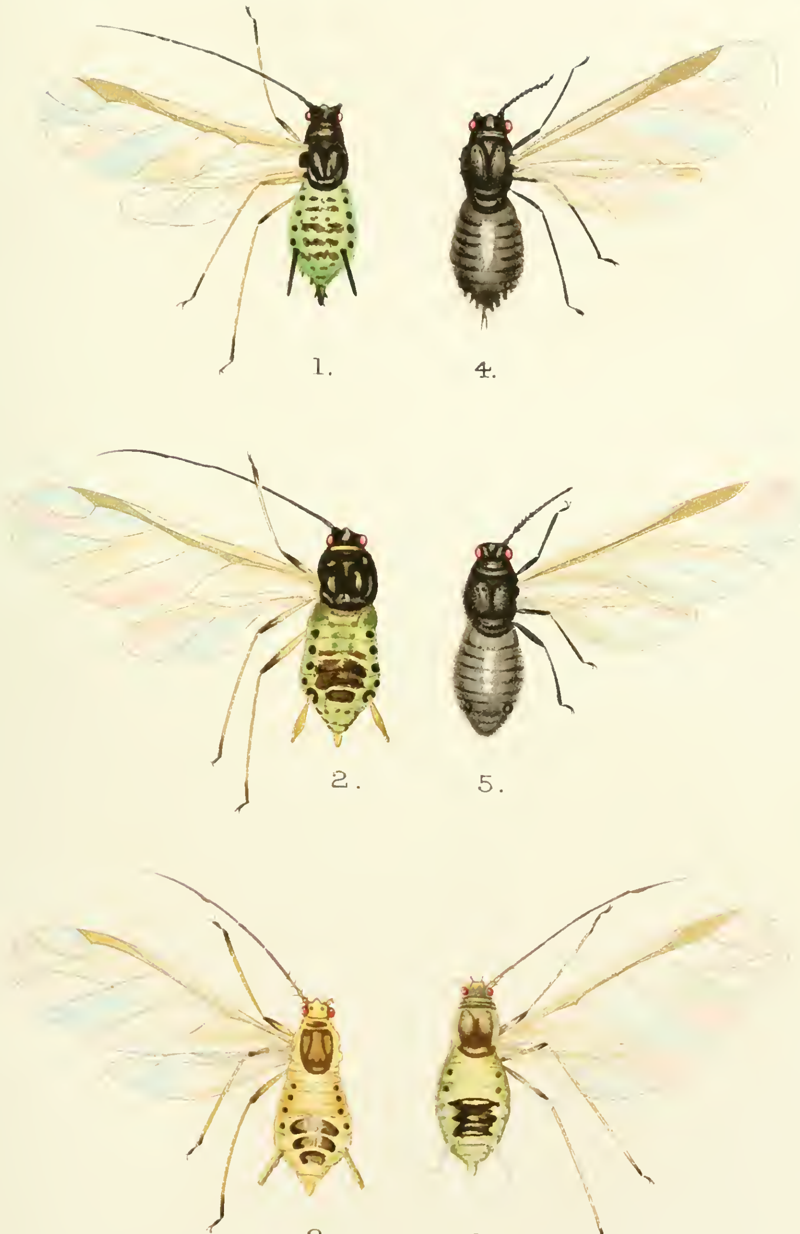
APHIDES ON RIBES.



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REVIEWS.

Eriksson, J.—Fungoid Diseases of Agricultural Plants. Pp. xii + 208, 117 figs. London: Baillière, Tindall and Cox, 1912. Price, 7s. 6d. net.

Dr. Eriksson's work on economic mycology is already well-known to most students of plant pathology. In the present work upwards of two hundred diseases are treated of, and all are excellently illustrated. The book is primarily intended as a practical guide for the grower, to enable him to recognize, prevent, and battle with these diseases, and the lucid manner in which they are described, together with the general protective measures given, should prove of great service. We commend the work to all interested as containing in a concise form a wealth of information.

Gillanders, A. T.—Forest Entomology. 2nd ed. Pp. xxiv + 428, 352 figs. London: William Blackwood and Sons. 1912. Price, 15s. net.

We welcome a second edition of Mr. Gillander's very useful work. We have already expressed our high appreciation of the first edition. In issuing a second edition the author has made several corrections and re-arranged the chapters, all of which tend to make the work more perfect. In its present form it must appeal to a wide circle of readers interested in the preservation of timber and forest preservation generally.

Leslie, A. S., and A. E. Shipley.—The Grouse in Health and Disease. Pp. xx + 472, 21 plts. London: Smith, Elder and Co., 1912.

This is an abridged and popular account of the results of the recent inquiry into "Grouse Disease," embodied in the excellent Report of the Grouse Disease Committee, issued last year.

It was a wise decision of the Committee to issue a popular edition, for the results obtained and the conclusions arrived at deserve to be made known to a much wider class than the original Report would reach.

In spite of condensation and reduction the work furnishes sportsmen and naturalists with a really practical guide, full of interest, and free from the technical details and pathological data, which have proved

so valuable in arriving at the various conclusions, but, of course, out of place in the present work.

The work is beautifully illustrated and should find a place in the library of all interested in game, whether from a scientific or sporting side.

Miall, L. C.—The Early Naturalists: their Lives and Work (1530-1789). Pp. xi + 396. London: Macmillan and Co., Ltd., 1912. Price, 10s. net.

Dr. Miall is to be congratulated upon the appearance of this valuable and interesting volume. Quite apart from its value respecting the life and work of the early naturalists, which is considerable, the naturalist, and particularly those interested in insect anatomy and insect life-histories, will find a wealth of information.

Hitherto students of biology have had no work to which they could turn for information of this kind, apart from the same author's *History of Biology*. The non-professional naturalist will find in the different lives much of interest; the failures and successes, the difficulties under which many of the earlier investigators worked, and how they were overcome.

The work is an admirable one for students for vacation reading, and we hope it will find a place in all the leading libraries.

Pearson, R. S.—Commercial Guide to the Forest Economic Products of India. Pp. ix + 155 + xiii, 6 plts. and map. Calcutta: Superintendent Government Printing, 1912. Price, 1s. 6d.

The author deals with his subject under three heads, viz., (i) the distribution and classification of the many types of forests found in British India; (ii) the commoner timber trees of India and Burma, with remarks on their distribution, quality and uses of the timber, its approximate value and yield in various localities, and to whom enquiries should be directed for further information on the subject; and (iii) the minor products, such as gums, resins, dye-products, etc. Useful indices to scientific and English and vernacular names are appended.

The work should prove of value to firms and persons interested in the subject, and at the same time it forms a useful handbook for reference.

Russell, E. J.—Soil Conditions and Plant Growth. Pp. viii + 168. London: Longmans, Green and Co., 1912. Price, 5s. net.

It is generally admitted that our knowledge of soil conditions, particularly in this country, has until quite recently been of a very vague character. Dr. Russell's work cannot fail but dispel much that has been regarded as "established facts," and at the same time it places before students in this country an admirable critical examination of the whole subject.

Whilst mainly devoted to the chemical side of the subject, the biological conditions in the soil and the soil in relation to plant growth, are briefly reviewed. In a future edition we trust these two subjects will be dealt with at greater length.

A concluding chapter on soil analysis and its interpretation, and an appendix on methods of soil analysis, add greatly to the value of the work.

CORRIGENDA.

Vol. VII, Part II.

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CURRENT LITERATURE.

I.—General Subject.

Annual Report of the Board of Scientific Advice for India for the Year 1910-11. Pp. 199. Calcutta: 1912. Price, 1s. 6d.

Bulletin of the Bureau of Economic and Social Intelligence. Nos. 4, 5 and 6. Rome: International Institute of Agriculture, 1912.

Bulletin of the Bureau of Agricultural Intelligence and of Plant Diseases. Nos. 4, 5, 6 and 7. Rome: International Institute of Agriculture, 1912.

Fawcett, H. S.—The Relation of Fungous Diseases to State and County Quarantine. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 234-236.

II.—Anatomy, Physiology, and Development.

Teodoro, G.—Le glandule laccipare e ceripare del *Lecanium oleae*, Bern. Redia, 1912, vol. 8, pp. 312-320, 2 figs.

III.—General and Systematic Biology, and Geographical Distribution.

Bär, H.—Beiträge zur Kenntnis der Thysanuren. Jena. Zeit., 1912, Bd. 48, pp. 1-92, T. i-vi u. 5 fign.

Berlese, A.—*Trombidiidae*. Redia, 1912, vol. 8, pp. 1-291, T. i and 137 figs.

Birger, K.—Mendelistische Studien an Rüben. Fühlings Landwirtsch Zeit., 1912, pp. 142-199.

Brunetti, E.—A new species of Blood-sucking Fly (*Simulium*) from Ceylon. Spolia Zeylanica, 1912, vol. 8, pp. 90, 91, 3 figs.

Cockerell, T. D. A.—Names applied to Bees of the Genus *Osmia*, found in North America. Proc. U.S. Nat. Mus., 1912, vol. 45, pp. 215-225.

Essig, E. O.—*Aphididae* of Southern California. VIII. Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 698-745, 16 figs.

Felt, E. P.—Observations on the Identity of the Wheat Midge. Journ. Econ. Entom., 1912, vol. 5, pp. 286-289.

Fernald, H. T.—Descriptions of Certain Species of Wasps of the Family *Sphecidae*. Proc. U.S. Nat. Mus., 1912, vol. 42, pp. 257-259.

Griffini, A.—Studi sopra alcuni *Grillacridi* del K. K. Naturhistor. Hofmuseum di Vienna. Redia, 1912, vol. 8, p. 292-311.

Hall, H. V. M.—Studies in Acarine. III. Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 749-751, 3 figs.

Imms, A. D.—On some Collembola from India, Burma, and Ceylon; with a Catalogue of the Oriental Species of the Order. Proc. Zool. Soc. Lond., 1912, pp. 80-125, plts. vi-xii.

A valuable contribution to our knowledge of the Oriental species. The value of the beautiful figures is considerably lessened by their not being printed on white paper.

Johannsen, O. A.—The *Mycetophilidae* of North America. Pt. III. Maine Agric, Exp. Stat., Orono, Bull. No. 196, 1911, pp. 249-328, 5 plts.

Johannsen, O. A.—The *Mycetophilidae* of North America. Part IV. Maine Agric. Exp. Stat., Orono, Bull. No. 200, 1912, pp. 57-146, 7 plts.

Kieffer, J. J.—Nouveau démembrement du genre *Clinodiplosis*. Marcellia, 1912, vol. 11, pp. 6-11.

Lindinger, L.—Eine weitverbreitete gallenerzeugende Schildlaus. Marcellia, 1912, vol. 11, pp. 1-6.

Linnaniemi, Walter M. (Axelson).—Die Apterygotenfauna Finlands. II. Spezieller Teil. Acta Soc. Scien. Fennicae, 1912, T. 40, no. 5, pp. 1-360, 16 tafn.

An exceedingly valuable work abounding in detail and a wealth of illustration.

Newstead, R.—A New Tsetse-Fly from British East Africa. Anns. Trop. Med. and Paras., 1912, vol. 6, pp. 129, 130.

Nowrojee, D.—Life-histories of Indian Insects—II. Some Aquatic Rhynchota and Coleoptera. Mem. Dept. Agric. India, Entom. Ser., vol. 2, no. 9, 1912, pp. 165-191, plts. xx-xxvi.

Pergande, Theo.—The Life-history of the Alder Blight Aphis. U.S. Dept. Agric., Bur. of Entom., Tech. Ser., No. 24, 1912, pp. 1-28, 12 figs.

Phillips, W. J., and J. J. Davis.—Studies on a New Species of *Toxoptera*, with an Analytical Key to the Genus and Notes on Rearing Methods. U.S. Dept. Agric., Bur. of Entom., Tech. Ser., No. 25, pt. i, 1912, pp. 1-16, plt. i and 9 figs.

Pictet, Arnold.—Recherches expérimentales sur les Méchanismes du Mélanisme et de l'Albinisme chez les Lépidoptéres. Mem. Soc. Phys. d'Hist. Nat. Geneve, 1912, vol. 37, pp. 111-278, pl. 1-5.

Russell, H. M.—An Internal Parasite of Thysanoptera. U.S. Dept. Agric., Bur. of Entom., Tech. Ser., No. 23, pt. ii, 1912, pp. 25-52, 11 figs.

Theobald, F. V.—Three New *Culicidae* from the Transvaal. Entom., 1912, pp. 92, 93.

Theobald, F. V.—Notes on *Rhopalosiphum solani,* Kaltenbach, Ibid., pp. 165-168, 2 figs.

Theobald, F. V.—The Percy Sladen Trust Expedition to the Indian Ocean in 1905. No. V. Diptera, *Culicidae.* Trans. Linn. Soc., 2nd ser. Zool., 1912, vol. 15, pp. 81-94, plt. 4 and 12 figs.

Timberlake, P. H.—A Study of the Biology of *Limnerium validum* (Cresson). U.S. Dept. Agric., Bur. of Entom., Tech. Ser. No. 19, pt. v, 1912, pp. 71-92, 10 figs.

Tothill, J. D.—Systematic Notes on North American *Tachinidae.* Can. Entom., 1912, vol. 44, pp. 1-5.

Townsend, C. H. T.—The Cotton Square-Weevil of Peru and its Parasites. Journ. Econ. Entom., 1912, vol. 5, pp. 252-256.

Woodworth, C. W.—Check List of California Insects. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 297-312.

IV.—Agriculture and Horticulture.

Ballou, H. A.—Insect Pests of the Lesser Antilles. Pp. ix + 210, 185 figs. Imp. Dept. Agric. W. I., 1912. Price 1s. 3d.

Bonno, W. W.—Orchard Spraying Problems and Experiments. 27th Ann. Rpt. Maine Agric. Exp. Stat., 1911, pp. 33-80, 20 figs.

Brooks, C.—Some Apple Diseases and their Treatment. New Hampshire Agric. Exp. Stat., Bull. 157, 1912, pp. 1-32, 30 figs.

Bryant, H. C.—The Economic Status of the Meadowlark in California. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 226-231, 2 figs.

Bryant, H. C.—The Lewis Woodpecker—A Destroyer of Almonds. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 362-366, 2 figs.

Burgess, A. F., and C. W. Collins.—The Value of Predaceous Beetles in Destroying Insect Pests. Yearbook U.S. Dept. Agric., 1911, pp. 453-466, plts. lvii-lxii and 6 figs.

Carnes, E. K., and E. J. Newcomer.—An Insect Enemy of Pasture-land and Growing Alfalfa. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 275-280, 3 figs.

Carpenter, G. H.—Injurious Insects observed in Ireland during the Year 1911. Econ. Proc. Roy. Dublin Soc., 1912, vol. 2, pp. 53-78, plts. viii, ix and 13 figs.

Chittenden, F. H.—A Little-known Eelworm (*Porosagrotis vetusta,* Waik.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 109, pt. iv, 1912, pp. 47-51, 1 fig.

Coleman. L. C.—Kumblihulas attacking Crops in Mysore (*Amsacta albistriga*, Wlk.). Dept. Agric. Mysore State, Entom. Ser., Bull. No 3, 1912, pp. 1-12, 1 plt.

Collinge, Walter E.—Sixth Annual Report of the Honorary Consulting Biologist. Journ. Land Agents' Soc., 1912, vol. 11, pp. 300-314.

Crawford, D. L.—The Petroleum Fly in California, *Psilopa petrolei,* Coq. Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 687-697, 11 figs.

Essed, E.—Cacao Canker. W.I. Bull., 1912, vol. 12, pp. 302-308.

Essig, E. O.—The Potato Tuber Moth (*Phthorimaea operculella*, Zeller). Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 203-213, 7 figs.

Essig, E. O.—Plant Lice affecting Citrus Trees. Part II. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 282-296, 10 figs.

Essig, E. O.—Three Destructive Diseases of the Peach. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 337-359, 4 figs.

Fawcett, H. S.—Two Apple Cankers. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 247-249, 2 figs.

Felt, E. P.—Twenty-seventh Report of the State Entomologist on Injurious and other Insects of the State of New York. N.Y. State Mus., Bull. 155, 1912, pp. 1-198, 27 plts. and 6 figs.

Fisher, A. K.—Crawfish as Crop Destroyers. Year-book U.S. Dept. Agric. 1911, pp. 321-324, plt. xxii.

Fletcher, T. B.—Termites or White Ants. Agric. Journ. India, 1912, vol. 7, pp. 219-239, plts. xxviii, xxix, and 13 figs.

Fron, M. G.—Contributions à l'Étude de la Maladie du Pied noir des Céréals, ou Maladie du Piétin. Ann. Sci. Agron., 1912, pp. 3-29, plts. i-iii.

Gibson, Arthur.—Cutworms and Army-worms. Dept. Agric. Canada, Div. Entom. Bull. No. 3, 1912, pp. 9-29, 1 plt. and 10 figs.

Green, E. E.—Shot-hole Borers (*Scolytidae* and *Bostrichidae*). Trop. Agric., 1912, vol. 38, No. 1, pp. 1-3.

Green, E. E.—Bird Life and its Effect on our Industries. Ibid., No. 2, pp. 1-3.

Green, E. E.—Supplementary Note on the Proposed Introduction of the Lac Insect into Ceylon. Ibid., p. 1.

Green, E. E.—Eel-worms. Ibid., No. 3, p. 1.

Green, E. E.—Formalin and House Flies. Ibid., No. 4, pp. 1, 2.

Green, E. E.—The Paddle-legged Bug (*Leptoglossus membranaceus*). Ibid., No. 6, pp. 1, 2.

Guppy, P. L.—Insect Pests of Cacao, W. I. Bull., 1912, vol. 12, pp. 310-320.

Henshaw, H. W.—Our Mid-Pacific Bird Reservation. Yearbook U.S. Dept. Agric., 1911, pp. 155-164, plts. i, ii and 2 figs.

Hewitt, C. G.—The Honey Bee. A Guide to Agriculture in Canada. Dept. Agric. Canada, Div. Entom. Bull. No. 2, 1912, pp. 1-45, 2 plts. and 9 figs.

Hewitt, C. G.—The Control of Insect Pests in Canada. Ibid., Bull. No. 4, 1912, pp. 5-13.

Hollister, W. O.—Tobacco Extracts, their comparative values as Insecticides. Journ. Econ. Entom., 1912, vol. 5, pp. 263-267.

Horne, W. T.—Fungous Root Rot. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 216-225, 7 figs.

Horne, W. T.—The Olive Knot. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 592-600, 5 figs.

Hoyt, A. S.—Natural Control of the Citrus Mealy Bug. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 231-234, 3 figs.

Hunter, W. D.—The Cotton Stainer (*Dysdercus saturellus*, H.-Schf.). U.S. Dept. Agric., Bur. of Entom., Circ. No. 149, 1912, pp. 1-5, 2 figs.

Hunter, W. D.—The Control of the Boll Weevil. U.S. Dept. Agric., Farm. Bull. No. 500, 1912, pp. 1-14.

Hunter, W. D.—Relation between Rotation Systems and Insect Injury in the South. Yearbook U.S. Dept. Agric., 1911, pp. 201-210.

Hyslop, J. A.—The Legume Pod Moth. U.S. Dept. Agric., Bur. of Entom., Bull. No. 95, pt. vi, 1912, pp. 89- , plts. x and 10 figs.

Hyslop, J. A.—The Legume Pod Maggot (*Pegomya planipalpis*, Stein.). Ibid., pp. 105-108, 4 figs.

Iyer, V. S.—A Further Note on some Casuarina Insect Pests of Madras. For. Bull. Calcutta, No. 11, 1912, pp. 1-9, 4 plts.

Johnston, J. R.—The History and Cause of the Coconut Bud-rot. U.S. Dept. Agric., Bur. Pl. Indus., Bull. No. 228, 1912, pp. 1-175, plts. i-xiv and 10 figs.

Johnston, F. A.—Arsenite of Zinc and Lead Chromate as Remedies against the Colorado Potato Beetle. U.S. Dept. Agric., Bur. of Entom., Bull. No. 109, pt. v, 1912, pp. 53-56.

Lefroy, H. M., and C. C. Ghosh.—Eri Silk. Mem. Dept. Agric. India, Entom. Ser., 1912, vol. 4, No. 1, pp. 1-130, 9 plts. and 11 figs.

Lipman, C. P.—Soil Bacteriology in the Service of Agricultural Practice. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 482-500.

McAtee, W. L.—Bird Enemies of the Codling Moth. Year-book U.S. Dept. Agric. 1911, pp. 237-246, plts. x, xi.

McRae, W.—Rows of Spots on the Leaves of Palmyra Palms. Agric. Journ. India, 1912, vol. 7, pp. 272-279, plts. xxxiii-xxxvii.

Main, T. F.—A Series of Campaigns against the Rice Grasshopper, *Hieroglyphus banian,* Fabr. Agric. Journ. India, 1912, vol. 7, pp. 246-256, plt. xxx.-xxxii.

Martin, C. H.—A Note on the Protozoa from Sick Soils, with some Account of the Life-Cycle of a Flagellate Monad. Proc. Roy. Soc., B. 1912, vol. 85, pp. 393-400, plt. 10.

Maskew, F.—Sweet Potato Stem Borer (*Omphisa anastomosalis*, Guen.). Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 249-253, 5 figs.

Maskew, F.—A Serious Walnut Pest (*Ephestia elutella,* Hubn.). Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 366-371, 10 figs.

Misra, C. S.—Litchi Leaf Curl. Agric. Journ. India, 1912, vol. 7, pp. 286-293, plt. xxxviii, xxxix and 2 figs.

Morris, E. L.—New Control Methods for the Pear Thrips and Peach Tree Borer. Univ. Calif. Agric. Exp. Stat., Bull. No. 228, pp. 367-374, 6 figs.

Morse, W. J.—Control of the Blackleg or Black-stem disease of the Potato. 27th Ann. Rpt. Maine Agric. Exp. Stat., 1911, pp. 201-228, 1 fig.

Pierce, W. D., and Others.—The Insect Enemies of the Cotton Boll Weevil. U.S. Dept. Agric., Bur. of Entom., Bull. No. 100, 1912, pp. 1-99, plts. i-iii and 26 figs.

Quaintance, A. L.—The Leaf Blister Mite (*Eriophyes pyri*, Pagenstecher). U.S. Dept. Agric., Bur. of Entom., Circ. No. 154, pp. 1-6, 4 figs.

Rorer, J. B.—Spraying Cacao. W. I. Bull., 1912, vol. 12, pp. 275-277.

Russell, H. M.—The Greenhouse Thrips (*Heliothrips haemorrhoidalis*, Bouché). U.S. Dept. Agric., Bur. of Entom., Circ. No. 151, 1912, pp. 1-9, 7 figs.

Schuster, J.—Zur Kenntriss der Bakterienfäule der Kartoffel. Arb. K. Biol. Anst. Land-u. Forstw., 1912, Bd. 8, pp. 452-492, T. i and 13 fign.

Severin, H. H. P.—The Introduction, Method of Control, Spread and Migration of the Mediterranean Fruit Fly in the Hawaiian Islands. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 558-565.

South, F. W.—Fungus Diseases of Cacao. W. I. Bull., 1912, vol. 12, pp. 277-302.

South, F. W.—The Application of Mendelian Principles to Sugar-Cane Breeding. W. I. Bull., 1912, vol. 12, pp. 365-377.

Steward, F.—The Effect of Certain Chemical Substances on the Vitality of the Buds of Potato-tubers, and their Disinfective Action on Potato Blight (*Phytophthora infestans*). Proc. Roy. Soc. Victoria, 1912, vol. 24, pp. 270-292, plts. lvii-lix.

Taylor, F. W.—Results of Seed Tests for 1911. New Hampshire Agric. Exp. Stat., Bull. 156, 1912, pp. 1-14.

Theobald, F. V.—Report on Economic Zoology for Year ending September 30th, 1911. Pp. 155, 37 plts. and 11 figs. London : Headley Bros. 1912. Price 2s. 6d.

Tucker, E. S.—The Rice Water-Weevil and Methods for its Control. U.S. Dept. Agric., Bur. of Entom., Circ. No. 152, 1912, pp. 1-20, 2 figs.

Urich, F. W.—Sugar-Cane Insects in Trinidad. W.I. Bull., 1912, vol. 12, pp. 388-391.

Webster, F. M.—Preliminary Report on the Alfalfa Weevil. U.S. Dept. Agric., Bur. of Entom., Bull. No. 112, 1912, pp. 1-47, 13 plts. and 27 figs.

Webster, F. M.—The Alfalfa Gall Midge (*Asphondylia miki*, Wachtt.). U.S. Dept. Agric., Bur. of Entom., Circ. No. 147, 1912, pp. 1-4, 6 figs.

Webster, F. M.—The Clover Mite (*Bryobia pratensis*), Garman. Journ. Econ. Entom., 1912, vol. 5, pp. 290-295.

Weeks, C. B.—The Control of Peach Curl Leaf. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 359-362, 2 figs.

Weinland, H. A.—The Mediterranean Fruit Fly in Hawaii. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 261-270, 5 figs.

Weinland, H. A.—Work on the Mediterranean Fruit Fly in Hawaii. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 570-583, 5 figs.

Woodhouse, E. J.—Potato Moth in Bengal. Agric. Journ. India, 1912, vol. 7, pp. 264-271.

Zimmer, J. F.—The Grape Scale (*Aspidiotus* (*Diaspidiotus*) *uvae*, Comst.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 97, pt. vii, 1912, pp. 115-124, plts. xvii-xix and 2 figs.

V.—Forestry.

Felt, E. P.—Elm Leaf Beetle and White-Marked Tussock Moth. N.Y. State Mus., Bull. 156, 1912, pp. 5-35, plts. i-viii.

Froggatt, W. W.—A Weevil, *Aesiotes leucurus*, Pascoe, destructive to Pine Trees, *Pinus halepensis*. Agric. Gaz. N.S.W., 1912, vol. 23, pp. 55, 56, 1 plt.

Hole, R. S.—Bark-Boring Beetle Attack in the Coniferous Forests of the Simla Catchment Area, 1907-1911. For. Bull. Calcutta, No. 10, 1912, pp. 1-21.

Snyder, T. E.—Insect Damage to Mine Props and Methods of preventing the Injury. U.S. Dept. Agric., Bur. of Entom., Circ. No. 156, 1912, pp. 1-4.

Vortriede, W.—The Treatment of Wounds and Cavities in Trees and Shrubs. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 254-257, 3 figs.

VI.—Fisheries.

Storrow, B.—The Prawn (Norway Lobster, *Nephrops norvegicus*) and the Prawn Fishery of North Shields. Rpt. Dove Marine Lab., Northumberland, 1912, n.s. 1, pp. 10-31.

VII.—Medicine.

Doane, R. W.—An Annotated List of the Literature on Insects and Disease for the Year 1911. Journ. Econ. Entom., 1912, vol. 5, pp. 268-285.

Useful, but not complete.

VIII.—Animal Diseases, etc.

Hindle, E.—Attempts to transmit "Fowl Pest" by *Argas persicus.* Bull. Soc. Path, exot., 1912, T. 5, pp. 165-167.

Hindle, E.—What is the Genus *Leptomonus,* Kent? Parasitology, 1912, vol. 5, pp. 128-134.

Hindle, E., and R. C. Lewis.—Note on "Crithidia" *cleti,* n.sp., parasitic in the alimentary canal of *Cletus varius,* Dall. Parasitology, 1912, vol. 5, pp. 109-113, 17 figs.

Morse, G. B.—Primary Principles in the Prevention and Treatment of Disease in Poultry. Yearbook U.S. Dept. Agric. 1911, pp. 177-192.

Pearl, R., F. M. Surface, and M. R. Curtis.—Poultry Diseases and their Treatment. 27th Ann. Rpt. Maine Agric. Exp. Stat., 1911, pp. ix + 216, 49 figs.

Phillips, E. F., and G. F. White.—Historical Notes on the Causes of Bee Diseases. U.S. Dept. Agric., Bur. of Entom., Bull. No. 98, 1912, pp. 1-96.

Stephens, J. W. W.—*Paropisthorchis caninus,* the Liver-fluke of the Indian Pariah Dog. Anns. Trop. Med. and Paras., 1912, vol. 6, pp. 117-128, plts. x-xii and 1 fig.

White, G. F.—The Cause of European Foul Brood. U.S. Dept. Agric., Bur. of Entom., Circ. No. 157, 1912, pp. 1-15, 10 figs.

IX.—Commercial.

Dewey, L. H.—Fibres used for Binder Twine. Yearbook U.S. Dept. Agric., 1911, pp. 193-200, plts. iii-v.

Haselhurst, H. W. R.—Some Observations upon the Chemical Composition and the possible Commercial Value of Seaweeds. Rpt. Dove Marine Lab., Northumberland, 1912, n.s. I, pp. 77-82.

Howard, B. J.—Decomposition and its Microscopical Detection in some Food Products. Yearbook U.S. Dept. Agric. 1911, pp. 297-308, plts. xv-xix.

Leake, H. M., and R. Pershad.—Observations on certain extra-Indian Asiatic Cottons. Mem. Dept. Agric. India, Bot. Ser., vol. iv, no. 5, 1912, pp. 93-114, plts. i-vii.

THE

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THE FUNGI OF THE BEE-HIVE.

By

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With 28 Figures.

The fungus-flora of the bee-hive is doubly of interest. From the point of view of the mycologist, it might be expected that a habitat providing such unusual conditions, as regards temperature and substratum, would contain some interesting forms. From that of the bee-keeper it is very desirable that our knowledge of the organisms found in the hive should be as thorough as possible, in order to facilitate the study and suppression of diseases of the honey-bee. In spite of these considerations, it appears that the bee-hive fungi have never been thoroughly worked out, though various species have from time to time been recorded as present in hives, mostly in connection (or supposed connection) with bee-diseases.

The following is believed to be a full account of all the hive-fungi hitherto described. Since many of the records occur in non-mycological periodicals, the descriptions are in many cases inadequate or even wanting; these cases have nevertheless been included, for the sake of completeness.

Berkeley and Broome (3) in 1854 described a new species, *Oidium favorum*, as follows:—" Floccis erectis septatis, sporis flavis brevibus subcylindricis. On honey-comb, near Woolwich, Mrs. Col. Jones. Flocci erect, white, septate and slightly torulose below, above bearing a few short cylindrical yellow spores. These spores when fallen seem to acquire a septum, and then to be gradually attenuated at either end. A new septum is then formed in each division, constituting an irregularly fusiform body." Cooke (5) follows Berkeley and Broome in his account of this species. Saccardo (25, iv, 22) transfers it to the genus *Oospora*. His diagnosis is: " Hyphis erectis septatis; conidiis luteis, brevibus subcylindricis ultimis sphæroideis. Hab. in favis Apum in Britannia." Massee (22) describes *Oospora favorum* as follows: " Tufts minute, white,

unconspicuous, hyphae branched, intertwined, septate, fertile branches erect bearing short chains of yellow, subglobose conidia, 4-5 μ. . . . On honey-comb. Rare (Type in Herb. Berk. Kew). An examination of type specimen shows the conidia subglobose and concatenate in short chains. When quite young the conidia are filiform."

Dönhoff and Leuckart in 1856 discovered a parasite in the chyle-stomach of the honey-bee. This organism was described by Hoffmann (15), and named *Mucor melittophthorus*; a supposed "oidium-form" being designated *Oidium leuckarti*. It has recently been pointed out[1] that the supposed *Mucor* spores were in all probability a stage of the protozoan parasite *Nosema apis*; and it is fairly obvious from Hoffmann's figures and description that he mistook detached cells of the stomach-epithelium full of *Nosema* spores for sporangia. *Mucor melittophthorus* must therefore be struck off the list of the Fungi. *Oidium leuckarti* apparently consisted of fragments of mycelium, which it is impossible to identify. These may have been merely ingested by the bees, but it is possible that the fungus was growing in the stomach (*cf.* Graham-Smith and Bullamore's experiment (12, p. 85) where *Aspergillus niger* and *Penicillium* were in some cases apparently induced to grow in the stomachs of *Nosema*-infected bees).

Higgins (14) in 1858 published an account of the death of some bees, caused, it was presumed, by a fungus. His description is, unfortunately, insufficient to determine the species which made its appearance on the dead bees, and which he did not name.

Preuss (24) in 1869 found *Penicillium crustaceum* to be common in hives in the spring.

Zorn and Hallier (30) in 1870 found *Thamnidium elegans* and *Myxotrichum chartarum* growing on diseased brood-combs. They erroneously supposed that these fungi were the cause of "foul-brood."

Cowan (6) in 1881 described a bee-disease, which occurred in Denmark in 1880, and appears to have been due to a fungus which was either a species of *Claviceps* or of *Cordyceps*. The drone-brood was the first to be attacked; the disease spread to the worker-brood; and finally the adult bees became diseased. The pupae dried up in their cells, and were permeated by mycelium. Stromata were subsequently developed. It is noted that ergot of rye was very

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[1] W. Hein, in a paper read at the Conference of German, Austrian and Hungarian bee-keepers, at Constance, August 8th, 1911. *Nosema apis* appears to be the causal organism of the "Isle of Wight" bee-disease (*11*).

plentiful in Denmark that year, and it is suggested that this was the source of the disease. Lack of material prevented a continuation of the work, so that the exact species concerned was not determined.

Bennemann and Hübner (2) in 1881 described *Mucor mucedo* as the cause of a bee-disease. According to their figures, this species had branched sporangiophores, a smooth sporangium-wall and globose spores. No dimensions are given. The *Mucor* was itself attacked by a parasite, a species of *Chaetocladium* (?); and the authors mention *Penicillium glaucum* as being also present on the bodies of the dead bees.

Howard (16, 17) in 1896 and 1900 recorded several fungi as present on diseased combs examined by him. Among them were *Penicillium glaucum*, an *Aspergillus* ("*Aspergillus pollinis*"), a species of *Mucor*, *Dactylium roseum*, species of *Hendersonia* and *Massaria*, and others. I have unfortunately been unable to see the 1896 paper, so cannot give any particulars as to the dimensions, etc., of *Aspergillus pollinis*, which, I believe, are there given.

Maassen (20) in 1906 described *Aspergillus flavus* as the cause of the bee-disease known in Germany as "Steinbrut." The course of this malady is somewhat similar to that of the disease described by Cowan (6). The brood becomes mummified and permeated by mycelium; the adult bees succumb later, at about the same time that the fungus on the dead brood develops its conidial stage. Hein (13) describes the disease; and adds (l.c., foot-note, p. 7) that, in a case of "Steinbrut" investigated by the Royal Institute for Bee-keeping at Erlangen, Bavaria, in 1910, the causal fungus was *Aspergillus fumigatus*. A case, evidently of the same disease, is described in the *Bienen-Zeitung* of 1860, p. 232. The species of fungus concerned was not, however, ascertained.

Material and Methods.

The present research was begun in 1909, and some knowledge of the species of fungi present in bee-hives was gained by examination of specimens of mouldy comb from healthy stocks. Reliable methods of sterilization were not adopted till July, 1910, however; and the results given in this paper are based on work done in 1911 and 1912, the material being nearly all derived from the combs of stocks which died during the winters of 1910-11 and 1911-12, of the prevalent "Isle of Wight" bee-disease.

Cultures were started by transferring samples of fungus from the combs, with sterilized implements, to test-tubes (more rarely to

Petri dishes or flasks) containing various nutritive media. In some cases, pure cultures were at once obtained; more usually, several sub-cultures had to be made before the species were separated. Drop cultures were made use of occasionally, chiefly in order to watch the germination of spores. Since December, 1911, the poured plate method has been almost exclusively employed in making cultures direct from the combs.

All the 1911 test-tube cultures were reliable, the tubes being sterilized as described below. The Petri dishes and flasks were unfortunately not sterilized with adequate thoroughness.[1] In the few cases, however, where my cultures of a species were originally derived from a culture made in a flask, Petri dish, or drop-culture cell (and consequently not absolutely reliable), subsequent work with poured plates (as well as an examination of combs) has verified the presence of the fungus on the combs, thus confirming the 1911 results.

Throughout the course of the work on which this paper is based, the methods of sterilization were as follows. All glass-ware (except drop-culture cells) was sterilized in an oven, test-tubes and flasks being previously plugged with cotton wool. After being filled with a suitable quantity of the nutritive medium, all tubes, whether intended for sloped tubes or for poured plate work, were sterilized by boiling in water for at least twenty minutes on three successive days (time being reckoned from beginning of ebullition of the water).[2] Forceps, wires, etc., were sterilized in a spirit-lamp flame.

The usual precautions were observed when removing and replacing the cotton wool plugs of culture-vessels.

The following media were used:—

Pollen-decoction. This was made by boiling in water pieces of comb in which the bees had stored pollen, and straining repeatedly till the wax, cocoons, and bulk of the pollen-grains were removed. It was made up with 1 to 2 grammes of bar agar-agar per 100 ccm. of decoction, or with gelatine,[3] and was usually left acid. This medium was used a good deal; but has latterly been for the most part abandoned in favour of the honey media.

Honey, diluted with 3 or 4 times its volume of water, was found to be an excellent medium for most of the fungi studied. It was generally made up with gelatine, but agar was also used. An

[1] The medium was boiled, and poured into the dishes and flasks, which were then used for cultures without further sterilization. They were nearly always kept for some days before use.

[2] The flasks used during 1912 were also treated in this manner.

[3] In all cases where gelatine was used, the proportions were: 10 grammes gelatine (Gold Label) to 100 ccm. of liquid.

attempt was made to cultivate the majority of the fungi on nearly pure honey, but it was not successful. This result was to be expected; as honey in the hive is very rarely, if ever, attacked by fungi (other than yeasts).

Pollen, strained out of the pollen-decoction, freed as far as possible from wax and cocoons, and with a little agar (less than 1 per cent.) to stiffen it, was used on one occasion for some of the fungi.

Prune-decoction was prepared according to Duggar's recommendation (9), 12 grammes of dried prunes to 100 ccm. of water. It was made up with either 1 or 3 grammes of agar per 100 ccm.; gelatine was tried, but presented no advantages. This medium was generally neutralized, and was frequently used with the addition of 2 ccm. of litmus solution to every 100 ccm. as a test for the production of acid.

Sugar-solution (10 grammes sugar to 100 ccm. water) with 2 grammes agar and 2 ccm. litmus solution per 100 ccm., was also used.

In addition to these, the following were experimented with in the case of several of the fungi:—

Bread, potato, apple, milk gelatine, bouillon agar, rice, sterilized horse-dung, decoction of horse-dung made up with agar, and portions of brood-comb (chiefly wax and cocoons) boiled down and sterilized.

Owing no doubt to the use, as a rule, of acid media, bacteria did not give any trouble; but many cultures were rendered useless by being overgrown with *Penicillium* or *Citromyces,* which were very plentiful on the material.

The fungi were tested for cuticularization as follows. Specimens were placed in drops of concentrated sulphuric acid, hydrochloric acid, and saturated caustic potash solution, on slips, and covered with cover-glasses. The effects of these liquids were noted, both when cold, and after heating over a flame till bubbles were expelled.

An incubator not being at my disposal, accurate determination of the germination-optima was not possible. Some experiments were however made with a view to getting some idea of the behaviour of the various fungi at different temperatures. Three exactly similar cultures of each species were started; one being exposed to temperatures ranging between 26°—42° C., the second to room-temperature (15°—19° C.), and the third being placed out of doors.[1] This experiment was repeated, in some cases more than once; the results agreed together very fairly.

[1] Mild winter weather; or during cool weather in May.

All measurements were made from pure-culture material (except in the case of *Gymnoascus setosus* and *G. ruber*, when the material was taken direct from the combs, attempts to cultivate these species not having been very successful).

Stains were used but little. Some specimens were stained with Haidenhain's Haemotoxylin in order to make more evident the structure of the young fruiting stages. Hoffmann's Blue was also employed occasionally.

The Relation of the Fungi to their Habitat.

It is difficult to determine which of the species here described are true bee-hive fungi; and which are merely casual saprophytes, only able to gain a footing in the hive after the death of the bees. Light may perhaps be thrown on the question by the consideration of the conditions prevailing in the hive, and of the behaviour of the fungi when growing at different temperatures and on various media; some account of the former matter will therefore not be out of place here.

The temperature in a bee-hive while the colony is active is maintained at 32°—34° C.[1]; in the winter months, when the bees hybernate in a cluster and breeding is at a standstill, the temperature appears to be about 12° C. in the cluster,[2] and is of course lower in the outer parts of the hive. There are no very exact determinations of the hygrometric state of the hive-atmosphere extant (so far as I can find); but there seems to be little doubt that it is decidedly dry. During the summer months the air is being continually changed, partly by convection, but chiefly by the bees' own efforts in "fanning" at the entrance, and so drawing the stale air out of the hive. In the winter the air is doubtless changed more slowly; but can evidently never be quite stagnant so long as the colony is alive. In a hive where the bees have died, the conditions are considerably different. The air is stagnant, and probably damper than in a healthy stock; and the temperature is that of the outside atmosphere. These conditions were reproduced with fair accuracy in the cultures referred to on p. 4, which were placed out of doors. The tubes were provided with rubber caps; in spite of this, the plugs became saturated with moisture in most (if not all) cases. The cul-

[1] M. Parhon. Ann. Sci. Nat. (Zool.), Series 9. Vol. IX, p. 39.

[2] Parhon gives 32°C. as the winter temperature (in the cluster), but the balance of opinion seems to be in favour of 12°C. Should the bees be disturbed, the temperature will rise temporarily to 32° (Tseselsky, Revue Int. d'Apiculture, 1894); whence perhaps Parhon's result, the insertion of the thermometer having disturbed the cluster.

tures at room temperature and at 26°—42° C. also had rubber caps; it is probable that they did not at all accurately reproduce the conditions prevailing in the healthy stock, perhaps because the air in them was too moist. At any rate, fungi which are known to be capable of growth (or at the least of survival in the form of spores) in the hive in summer, were killed in the high temperature series, even in cases where the maximum temperature attained probably did not exceed 38° C.

Fungi are found growing on various substrata in the hive. The stored pollen is perhaps the chief; it is the chosen pabulum of *Pericystis alvei* (4), and possibly of other species also. The most luxuriant and conspicuous fungous growth in the hive is usually to be found upon it. The rubbish, consisting largely of fragments of waste wax, which accumulates on the hive-floor, is full of spores, and is often over-grown by a film of mycelium. These are the only situations in which fungi can establish themselves in healthy stocks; dead bees, which form an excellent substratum, are usually ejected from the hive before any fungi can develop on them. In hives where the bees have died, however, almost any of the contents may become mouldy. (The exception is the honey, which appears to be immune from the attacks of fungi other than some yeast-forms which cause it to ferment[1]). In particular, when the stock has succumbed to the "Isle of Wight" disease, and the cluster has died *in situ* during the winter, many fungi flourish on the dead bees adhering to the combs; several of these have not been met with in other situations in the hive.

But little is known as to the sources from which the various fungi are brought into the hive. Some are probably not found elsewhere, and must be carried from hive to hive principally by the bees themselves. That swarms do carry fungus spores with them, as was suggested in the case of *Pericystis alvei* (4), has been confirmed by an experiment made in May, 1912. Bees, taken direct from a swarm, were shaken up in two flasks and a large test-tube containing some honey gelatine; the bees were then liberated, and the vessels put aside at room temperature for a few days. No growth resulted in the tube, perhaps because the layer of gelatine was thin and became too dry for germination to take place. In the flasks, however, *Citromyces subtilis*,[2] *Aspergillus glaucus*, and

[1] No attempt has been made in this paper to deal with the hive yeasts; but several species are known to be present, either constantly or occasionally.

[2] This *Citromyces* had the morphological characters of the species believed to be identical with *C. subtilis*; its acid-producing capacities were not, however, investigated.

(in one of them) *Penicillium crustaceum* made their appearance. No mould had been noticed in the combs when the hive from which the swarm issued was inspected in April; this perhaps accounts for the absence of *Pericystis alvei* from the cultures.

Some of the fungi which are brought into the hive seem unable to establish themselves in it. This is naturally the case with specialized parasites such as *Ustilago* (the spores of which are sometimes mistaken for pollen by the bees and collected as such); but it occurs also in instances where a different result might be expected. The most striking is that of a species of *Cladosporium*, the conidia of which are frequently present on the bodies of bees and in the pellets of pollen carried into the hive during the summer and autumn (as has been proved by cultures).

None of the species here discussed appear to be pathogenic. The presence of much mould in a stock is, however, if not a cause, at any rate a sign of unhealthy conditions. It indicates either that the hive is not weather-proof, or that the colony is weak; and is moreover a source of much labour to the bees in the spring, when they have to remove the hard plugs of mouldy pollen from the combs, a process which often necessitates the breaking down of the cell-walls.

The Fungi.

The twelve species here described probably include all those which are frequent in bee-hives, besides several less common fungi. The list does not, however, pretend to be an exhaustive one; some further species are known to occur in the hive, but have not been sufficiently worked out for inclusion in the present paper.

Eremascus fertilis, Stoppel.

This species is not common in bee-hives, but has been met with once or twice.

The appearance and dimensions agree well with those given by Stoppel (27). The fungus consists of delicate septate hyphae, bearing numerous asci, which (in younger cultures) may be found of all ages on a single hypha. The ascus arises as follows. Processes grow out from two adjacent cells, close to the septum between them (Fig. 1). These fuse, and the tip of the flattened loop so formed swells, is cut off by septa from the supporting hyphae, and finally develops into the ascus (Figs. 2, 3). Each ascus contains eight spores. Possibly the number of spores, as also the method of

formation of the ascus, may vary occasionally (Stoppel, pp. 337-8, 335). The spores are of an asymmetrical pointed oval form, and usually measure $6 \times 3\ \mu$. (Stoppel gives $5.2 \times 3\ \mu$ as the average). The ascus is $10\ \mu$ in diameter.

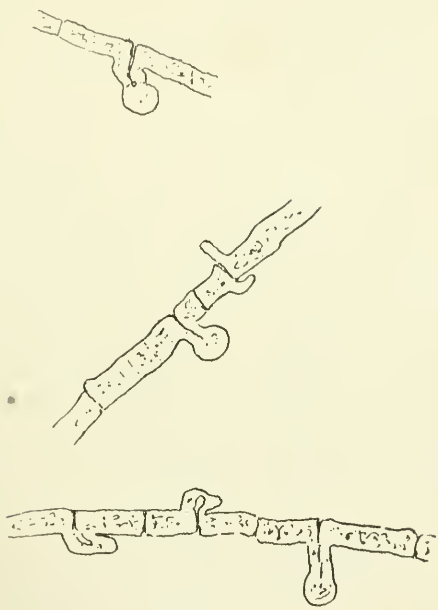

Fig. 1.—*Eremascus fertilis.* Formation of ascus. × 1,400.

Fig. 2.—*Eremascus fertilis.* Formation of ascus; older stage. × 1,400.

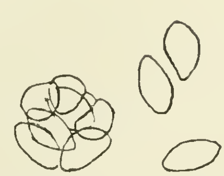

Fig. 3.—*Eremascus fertilis.* Ripe ascus and ascospores. × 1,400.

An old culture has the appearance of a mass of asci; the fungus, as stated by its discoverer, being exceedingly prolific. The naked-eye colour is whitish. The spores, before germinating, swell up considerably and become globose (27, p. 334).

The asci and spores are not immediately affected by immersion in hydrochloric acid or caustic potash solution, even when heat is applied, except that they are rendered more transparent. In sulphuric acid they are rendered very transparent, and on the application of heat are disorganized.

The fungus was only once cultivated on gelatine; but appeared to grow more luxuriantly on this than on agar (as is noted by Stoppel). Gelatine is not liquefied. No acid is produced, so far as could be ascertained. Germination took place sooner at room-temperature than out of doors. The fungus appears to dislike high temperatures.

This species has not been found often enough for any very definite statements to be made as to its favourite pabulum in the hive; but it appears to grow on the pollen, and was once found associated with *Pericystis alvei*. It has not so far been recorded from healthy stocks; but there is no reason whatever to suspect it of being pathogenic.

Gymnoascus setosus, Eidam.

A fungus believed to be identical with the above is fairly common in bee-hives. My specimens differ in some respects from *G. setosus*; but the differences were not considered sufficient to warrant the making of a new species.

The fungus does not grow in tufts or balls, but forms a smooth layer, whitish at first, becoming pale sulphur-yellow when the asci are formed; when oidia are plentiful, the colour is greenish-grey. The hyphae are of two kinds; thick-walled, much branched, spiny, olive-brown hyphae, 4 μ in diameter (Fig. 4), which are embedded in a tangle of thin-walled, somewhat granulated hyphae of a yellow colour, 1-4 μ in diameter; on some of the thicker of these the asci are borne, aggregated in small groups. The asci are globose, 9-10 μ in diameter; each contains eight ascospores. The ascospores are oval, 5×3 μ, tinged with yellow (Fig. 5). (The dimensions given by Massee and Salmon (23) for *G. setosus* are:—asci 7-8 μ, spores $5\text{-}7 \times 2$ μ). The oidia occur frequently, and are of the type figured by Dale for *G. candidus* (8, Pl. xxviii, fig. 56). The oidium-hyphae are branched, and break up easily when mature. The oidia are cylindrical or globose, 2.5-3 μ (Fig. 6). There is probably a

conidial form of this fungus; but this cannot be stated positively, as pure cultures of the other forms have not yet been obtained.

The formation of the asci seems to follow the course usual in *Gymnoascus* (Fig. 7).

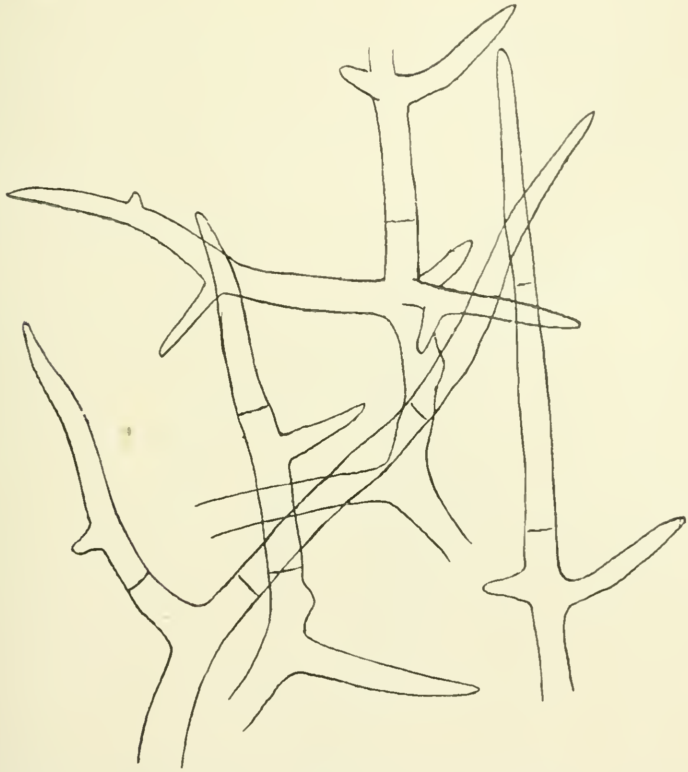

Fig. 4.—*Gymnoascus setosus.* Thick-walled brown hyphae. × 1,400.

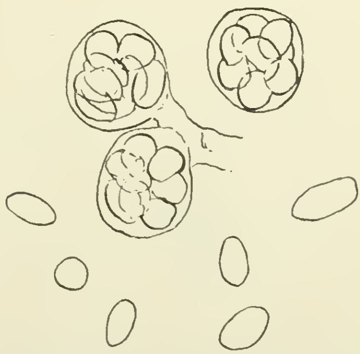

Fig. 5.—*Gymnoascus setosus.* Asci and ascospores. × 1,400.

The thick-walled brown hyphae are not affected by heating in sulphuric acid. Cold sulphuric acid dissolves the thin-walled yellow hyphae, and the liquid in their vicinity is coloured a rich magenta.

The fungus appears to be specialised for growth in the hive, as attempts to obtain pure cultures on artificial media have hitherto failed. It is interesting to note that the oidium-form grew well, and the ascus-form occasionally, in cultures heavily infected with *Penicillium* (which was present on the combs with the *Gymnoascus*).

The fungus appears to prefer empty brood-cells to any other substratum in the hive, but has been found on the cappings of dead pupae; also in pollen-cells, mingled with *Pericystis alvei*. It has been met with in a healthy stock, but evidently flourishes best after the death of the bees.

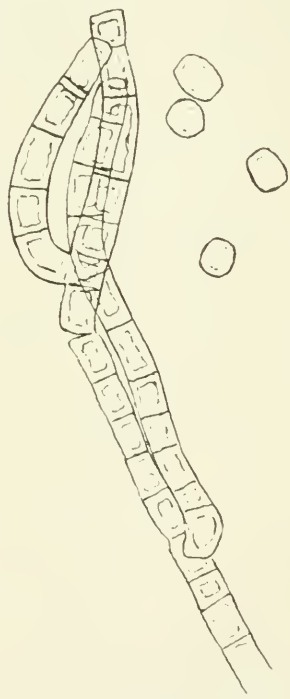

Fig. 6.—*Gymnoascus setosus*. Oidium-hypha and oidia. × 1,400.

Fig. 7.—*Gymnoascus setosus*. Conjugation of hyphae. From specimem stained with haematoxylin. × 1,400.

Gymnoascus ruber, Van Tieghem.

This species has only once been met with; it was growing on the dead cluster in a stock which died out during the winter of 1911-12. The fungus formed dull brick-red tufts on the dead bees or on the edges of the cells where they are clustered.

The hyphae vary in size and appearance; they are branched in an irregular manner, are apparently not rigid, and do not end in hooks or spines. They are usually 1-4 μ in diameter; some of the

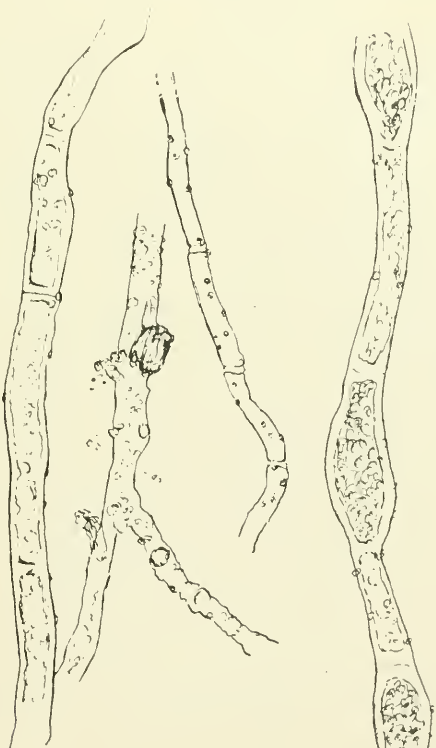

Fig. 8.—*Gymnoascus ruber*. Granulated hyphae. × 1,400.

thicker ones have swollen cells at intervals (Fig. 8). The surface bears scattered orange granulations. The asci are globose, 9-10 μ in diameter, and are borne on the hyphae in groups of about six; each ascus contains eight ascospores. The ascopores are globose or oval, tinged with yellow, 3.5-5 μ in diameter (Fig. 9). (These dimensions agree well with those given for *G. ruber* by Saccardo (25): asci 10-12 μ in diameter, spores 4.5-5.5 μ). Asci have so far not been

produced in cultures; but in one culture (on honey agar) oidia were developed. The vegetation was sparse, and of a pale salmon colour; the oidia are globose or subglobose, 5 to 6.5 μ. The oidium-hyphae fall to pieces very easily when immersed in weak spirit (Fig. 10). It is probable that there is a conidial form, but this remains to be verified.

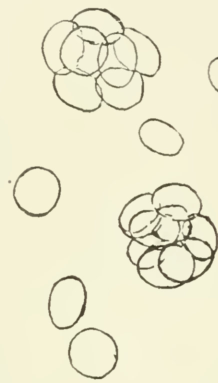

Fig. 9.—*Gymnoascus ruber*. Asci and ascospores. × 1,400.

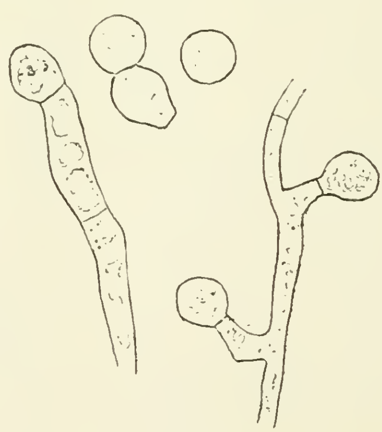

Fig. 10.—*Gymnoascus ruber*. Oidium-hyphae and oidia. × 1,400.

The red colour of the hyphae is destroyed by immersion in sulphuric and hydrochloric acids; this effect is also produced by caustic potash solution on the application of heat. Heating in sulphuric acid destroys the hyphae, and renders the asci and spores very transparent.

Aspergillus glaucus, Link.

This species is frequent in hives, especially after the death of the colony.

The dimensions of my specimens agree well with those given for *Aspergillus glaucus*. The conidiophores are from 0.5 mm. to over 1 mm. in height, and 5-10 μ (average 8 μ; an exceptional one as much as 15 μ) in thickness. The inflated apex is spherical, 25-40 μ in diameter. The sterigmata are oval or bottle-shaped,

Fig. 11.—*Aspergillus glaucus*. Conidiophore and conidia. × 1,400.

10 × 4 μ; they cover most of the surface of the sphere, and are directed radially outwards (Fig. 11). The conidia are elliptical or subglobose, 10-6 × 8-4 μ (in old cultures some are irregular in shape, *cf.* Mangin, 21, p. 337). They have a projection at one end where the adjoining conidium was attached, are echinulate, and greenish in colour (Fig. 11). The perithecia are of the usual *Eurotium* type, and are produced plentifully in most cultures. They are globose or

subglobose, 240 × 200 μ to 70 μ (average about 140-180 μ) in diameter. The asci are numerous, spherical or subglobose, 15-20 μ (average 17-18 μ) in diameter; each ascus contains eight ascopores of the usual form (Fig. 12), 8 × 5 μ.

The naked-eye colour of the vegetation is at first white, then bluish-green, later of a dull (brownish) green. The perithecia are bright sulphur-yellow in colour.

In some cultures a violet colouring matter made its appearance; in others, the culture when viewed from behind appeared reddish-orange. These were evidently the phenomena described by Mangin (21, pp. 349-351) as occurring with some varieties of *Aspergillus glaucus*. He states that the violet coloration appears in neutral or slightly alkaline, the red in slightly acid cultures; and that the pigment concerned is very sensitive to variations in the acidity or

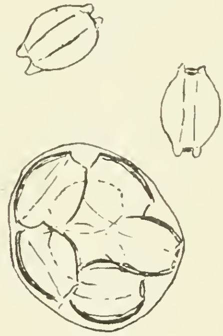

Fig. 12.—*Aspergillus glaucus*. Ascus and ascospores. × 1,400.

alkalinity of the medium, so much so that alterations taking place during the growth of the fungus affect it. As my estimations of the acidity and alkalinity of media were only made roughly, with litmus paper, no conclusions can be drawn from the results of the cultures as to this last point.

The conidiophore-stalk, sterigmata, and conidia survive heating in sulphuric and hydrochloric acids, but the former dissolves the basal part of the conidiophore-stalk. The perithecium wall, and especially the ascospores, partially resist hydrochloric acid, but disappear entirely on heating in sulphuric acid. In hot concentrated solution of caustic potash, all parts except the asci and ascospores are more or less disorganized; the perithecium-wall is ultimately coloured red-brown. The conidia become resistant earlier than the conidiophore-stalk and sterigmata; for, if young specimens be heated in sulphuric acid, only the conidia remain.

This species appears to dislike high temperatures, but is able to germinate, on being transferred to room temperature. At room temperature the fungus does well. Growth takes place under outdoor conditions, but germination is sometimes delayed.

This species does not liquefy gelatine (in one culture some liquefaction occurred). No acid is produced, as far as could be seen from cultures on litmus media.

Aspergillus nidulans, Eidam.

A fungus which is believed to be this species has been met with occasionally in dead stocks; it has not so far been demonstrated with certainty to be present in healthy stocks.

The conidiophore-stalk is 6-10 μ in diameter; it seldom, in my specimens, exceeded 1 mm. in height. The apex thickens somewhat gradually; the inflated tip is 14-21 μ in diameter (18-20 μ are about the average dimensions). The upper part of the stalk is thick-walled and is often brown in colour. The sterigmata are compound, and are borne on the upper surface of the conidiophore-apex (Fig. 13); the primary sterigmata are 10-8 × 2 μ; the secondary, 9-7 × 2 μ. The conidia are oval or subglobose, very slightly echinulate, 3-7 μ in diameter (4.5 × 3 μ being perhaps the average) (Fig. 13).

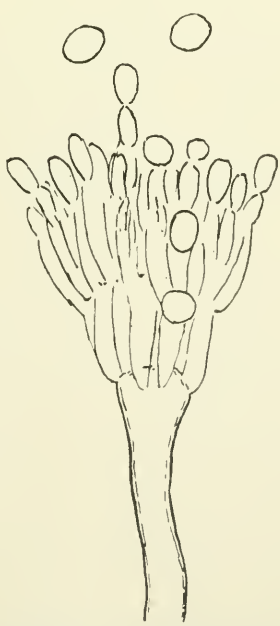

Fig. 13.—*Aspergillus nidulans.* Conidiophore and conidia. × 1,400.

On honey agar on two occasions sclerotia were produced. They are irregularly globose sulphur-yellow bodies, 1-2 mm. in diameter; and were crowded together at the foot of the agar slope. Each consisted of a tangle of numerous thick-walled cells, 12-30 μ in diameter (average 20-25 μ; some large oval ones to 40 × 35 μ; see Fig. 14). Their appearance is exactly that figured by Saito (26; Pl. iii, Fig. 11g) for the sclerotium of *A. nidulans*. The asci were not developed, even in one culture which was kept for about five months after the sclerotia first began to form.

The naked-eye colour of the vegetation is at first greenish-yellow, later a deep bright green, which does not become brownish and dull as in the case with *Aspergillus glaucus*.

The upper (brown) portion of the conidiophore-stalk, and the conidia, survive heating in sulphuric acid; the sterigmata seem able to resist this acid when cold, but disappear on heating. The upper

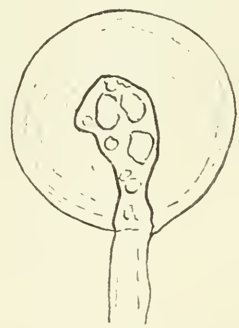

Fig. 14.—*Aspergillus nidulans*. Thick-walled cell from sclerotium. × 1,400.

part of the stalk-apex is more fragile than the rest of the conidiophore, and is of a lighter brown colour; it is very apt to break away when the stalk is heated in sulphuric acid. Hydrochloric acid does not seem to affect any parts. Heating in caustic potash solution extracts a yellow colouring-matter from the mature green conidia.

The conidia are apparently killed by exposure to temperatures of 26°—42° C., or even 38° C.; for cultures under these conditions not only did not germinate, but seemed incapable of doing so when transferred to room temperature. Under outdoor conditions germination took place, but was delayed. The fungus did well at room temperature. (In the matter of their behaviour at higher temperatures, my specimens differ from *A. nidulans* as described by Lindau 19, p. 139); he gives 38—42° C. as the optimum. He also gives 8 μ and 7 μ as the lengths of the primary and secondary sterigmata

respectively; and describes the conidia as spherical, 3 μ in diameter; otherwise the agreement is close).

This fungus grows well on honey agar, prune decoction agar, and apple; on the other media tried it either grew poorly or produced much sterile mycelium. Gelatine was invariably liquefied; consequently the fungus did not do well on gelatine media. No acid was produced.

Crookshank (7, p. 588) remarks that "bread and potatoes acquire a reddish-brown colour" when *A. nidulans* is cultivated on them. This was verified in both cases; but my fungus did not do well on either substratum. The effect was also observed in the case of apple, which was turned a dark-red brown; and a tendency to a darkening of the medium was also noticed in a culture on sugar solution with litmus.

Citromyces glaber, Wehmer.

This species was originally obtained from a living stock, but has since been cultivated from material from dead stocks, and is probably common in hives.

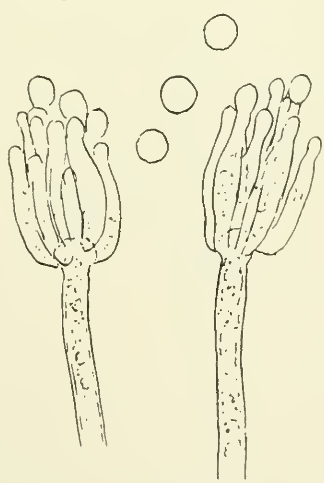

Fig. 15.—*Citromyces glaber.* Conidiophore and conidia. × 1,400.

The conidiophore is 2.5—3 μ in diameter, septate, rarely if ever branched. The apex is slightly inflated, 5—8 μ in diameter. The sterigmata are elongated oval, pointed at their distal ends, directed parallel to the long axis of the conidiophore, 10 × 3 μ (Fig. 15). The conidia are spherical, smooth, 2.3 μ to barely 3 μ in diameter, often forming long chains. Bodies probably of a sclerotial nature were met with in one culture on prune decoction agar. They were oval,

tawny-yellow in colour, 680-500 × 560-400 μ, and were partially embedded in the mycelium. They were evidently immature when examined; asci were not found.

The naked-eye colour of the vegetation is similar to that of *Penicillium*, but lighter and greyer. The fungus produces a yellow or brown coloration on some media (prune decoction agar and honey gelatine, for example); when grown on rice, it colours the rice a bright yellow (see Wehmer, 28).

The conidia and hyphae survive immersion in cold sulphuric acid; on the application of heat, the conidia only remain. A similar result ensues on heating in hydrochloric acid. Cold hydrochloric acid and caustic potash solution do not produce any immediate effect on the specimens. Hot caustic potash solution extracts a yellow colouring matter from the conidia.

This species is unable to endure high temperatures; the cultures at 26°-42° C. were all killed. Germination took place out of doors in May as quickly as at room temperature (in three days), but was inhibited during the winter. At room temperature the fungus did well. These observations are in accordance with Wehmer's results (28); he gives the limits of germination as 8°-32° C., optimum 20°-25° C. The swollen apex of the conidiophore, in his specimens, measured 4-15 μ, the sterigmata 9-12 × 3-4 μ. In other respects the fungus here described agrees well with Wehmer's.

This species liquefies gelatine; a considerable quantity of acid is produced, as is shown by the reddening of media containing litmus. The vegetation was grey, instead of green, on bouillon agar. The fungus grew well on a 5 per cent. solution of citric acid to which 2 grm. of agar per 100 ccm. had been added. (The medium remained liquid).

Citromyces subtilis, Bainier and Sartory.

This species is very common in hives, whether more so than the last it is not possible to say, as they resemble each other closely, and have doubtless often been confused.

The conidiophore is 3 μ in diameter, generally branched, having a septum just above the branch. The apex is slightly inflated, 3-5 μ in diameter. The sterigmata are of the usual form, 8-10 × 2 μ, directed parallel to the conidiophore-stalk. (Fig. 16). The conidia are spherical or subglobose, 2.5-3 μ (a few 4 μ) in diameter. No sclerotia have so far been observed.

The naked-eye colour of the vegetation is approximately that of *Penicillium*, that is to say slightly darker and less grey-green than

that of *C. glaber*. This species does not appear to produce any colouring matter, nor to discolour the medium on which it grows.

In sulphuric acid all parts of the fungus are rendered very transparent; on heat being applied, the conidia only remain. Hydrochloric acid produces no immediate effect; on heating, the conidia remain, also some hyphae; but the latter are considerably disorganised. Caustic potash extracts a yellow colouring matter from the conidia even when cold.

This species is more tolerant of high temperatures than *C. glaber*. Cultures at 26°-42° C. germinated, and in some cases produced a few conidiophores. At room temperature the fungus did well, also under outdoor conditions (May).

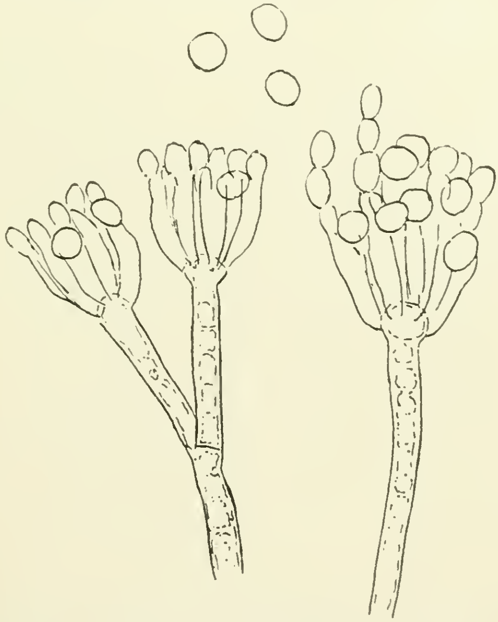

Fig. 16.—*Citromyces subtilis*. Conidiophore and conidia. × 1,400.

Only one gelatine culture was made; after 15 days some liquefaction had taken place. Several cultures on media with litmus were made; in no case was any reddening of the medium seen, so that acid is evidently not produced. The fungus is therefore probably *C. subtilis*; Bainier and Sartory (1, p. 46) describe this species as peculiar in that it produces no citric acid. Their specimens had conidia 2-2.5 μ, inflated apex 8-10 μ; in the manner of branching they resembled the fungus here described. Bainier and Sartory's species liquefied gelatine slowly; liquefaction began 16 or 17 days after germination.

Penicillium crustaceum, Linn.

This ubiquitous species is, as might be expected, common in bee-hives. It will grow on nearly any part of the contents of the hive, but is not usually found in great quantity until after the death of the stock.

An interesting point is the occurrence of two varieties differing chiefly in the size of their conidia. The one, which is probably more

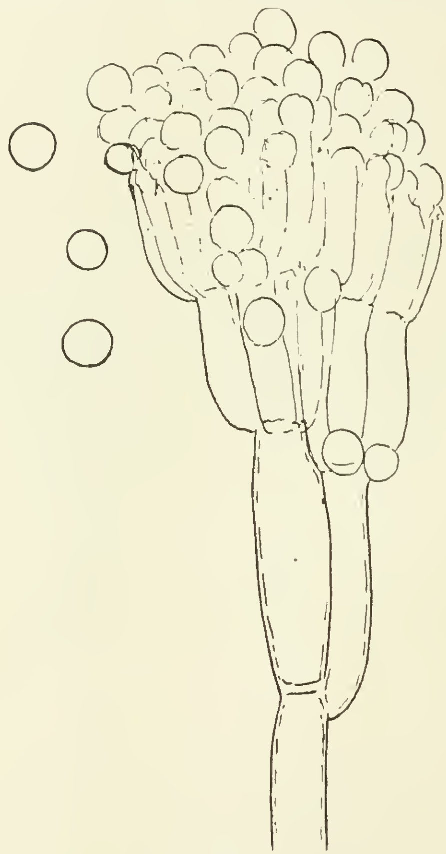

Fig. 17.—*Penicillium crustaceum*. Conidiophore and conidia (3-5 μ). × 1,400.

prevalent, has conidia 3-5 μ in diameter. The conidia of the other are 2.5-3 μ in diameter; this is perhaps the species studied by Brefeld, and referred to by him as *Penicillium glaucum* (Lafar, 18, p. 333).

The conidiophores are much alike in the two cases, and are of the usual *Penicillium* form (Figs. 17, 18). The sterigmata are 10-15 μ in length in both varieties (perhaps 10-12 μ in the form with small conidia). The branches bearing them are 15-17 μ in

length (15-16 μ in the form with small conidia). In both the conidiophore-stalk is about 5 μ in diameter.

The colour of the vegetation is very similar in both forms, but there seems to be a slight tendency for the form with smaller conidia to produce a paler, greyer, or more bluish-green vegetation than that of the other.

Only the conidia appear able to resist the action of sulphuric acid when heat is applied. No particular effect is produced by hydrochloric acid or caustic potash solution.

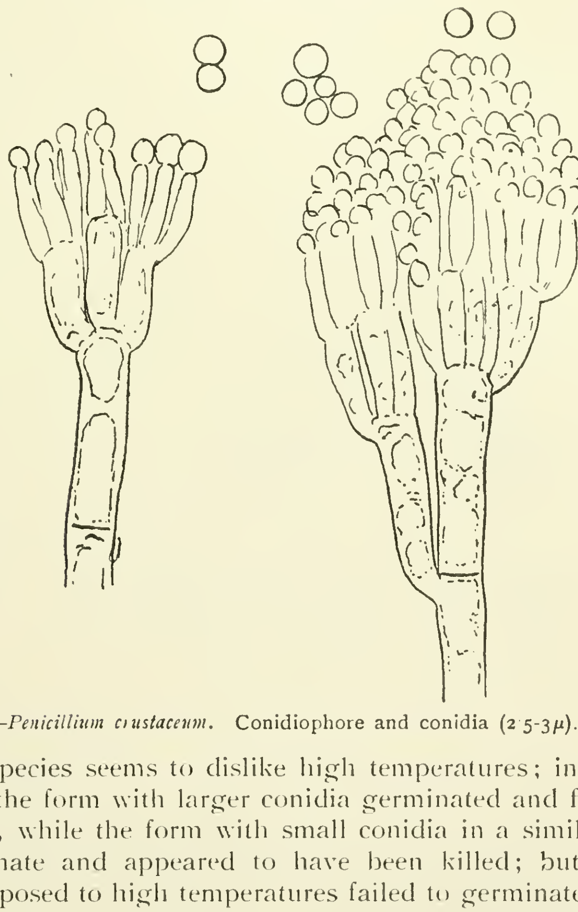

Fig. 18.—*Penicillium crustaceum.* Conidiophore and conidia (2·5-3 μ). × 1,400.

This species seems to dislike high temperatures; in one case a culture of the form with larger conidia germinated and flourished at 26°-38° C., while the form with small conidia in a similar tube did not germinate and appeared to have been killed; but as a rule, cultures exposed to high temperatures failed to germinate even when transferred to room temperature. At room temperature and under outdoor conditions the fungus did well.

Gelatine is not liquefied. In some cases litmus media were reddened, but the production of acid is evidently not so great as in the case of *Citromyces glaber.* The vegetation on bouillon agar was grey instead of green.

Sordaria fimicola, Rob.

This species has been cultivated once or twice from mouldy combs, but is evidently only very occasionally present in the hive. Its presence in healthy stocks has not been demonstrated with certainty. It is probably carried into the hive by bees seeking water in places to which horses have access.

The dimensions here given are for the most part taken from material cultivated on horse-dung. The perithecia are pear-shaped, or globose, with a curved neck, 280 μ in diameter; on some media they only attain 75 μ. The asci are cylindrical, narrowing to a stalk (Fig. 19); the sporiferous portion is 145×14 μ; the tip is slightly thickened. The asci in each perithecium are, in a fairly young

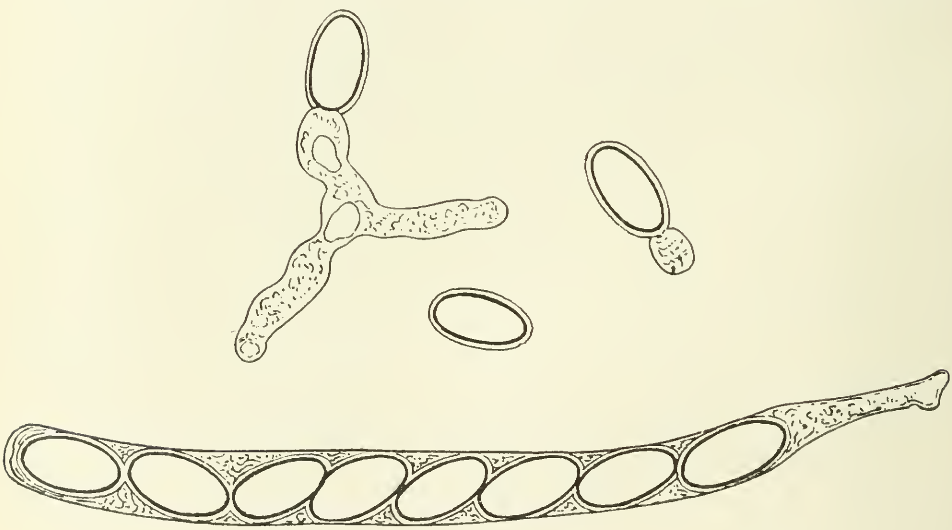

Fig. 19.—*Sordaria fimicola.* Ascus, ascospores, germination. × 640.

culture, of various ages. The paraphyses are irregularly swollen, septate, transparent hyphae. The ascospores are eight in each ascus, in a single row; each spore has its germination-pore directed towards the stalk-end of the ascus. The spores are dark brown in colour, 20×12 μ; they have a gelatinous integument, and (usually) one vacuole. They germinate by the emission from the pore of a spherical bladder, from which a hypha or hyphae then proceed (Fig. 19).

These dimensions agree well with those given by Winter (29, p. 166) for *Sordaria fimicola.*

On heating in sulphuric acid, a reddish colouring matter is extracted from the ascospores, and the ascus-wall is dissolved; the other parts of the fungus resist the action of the acid. On heating in caustic potash solution, oil-drops appear to exude from the ascospores.

This species has a preference for warmth, cultures at 26°-38° C. germinating more quickly than those at room temperature, at which, however, the fungus did well. Under out-door (winter) conditions, germination was delayed and the fungus did not flourish.

This species grew well on horse-dung, potato, and pollen. It seems to dislike acid media, but could grow on them. Gelatine was liquefied. No acid was produced.

Mucor erectus, Bainier.

This species is very common in and about hives, occurring principally as a saprophyte on dead bees. It is improbable that it is able to flourish in the living stock; but its spores are frequently present on the alighting-boards and about the entrances of hives. The fungus has also been cultivated from pellets of pollen taken from home-coming bees, and from the bodies of the bees themselves.

The vegetative hyphae are of the type usual in the genus, branched, non-septate, and containing oil-drops. At intervals swellings occur. The sporangiophores are branched, having always a septum above the branch; in thickness they vary from 9 μ to 20 μ (in exceptional cases portions of the sporangiophore may attain 38 μ). They are not rigid, but lean up against each other in a tangled

Fig. 20.—*Mucor erectus.* Columellae. × 1,400.

manner; they exhibit strong positive heliotropism. The sporangium is spherical, greenish-grey when mature, 70-190 μ in diameter. The sporangium-wall is semi-transparent, smooth, and very fugitive when mature; it usually deliquesces if it so much as touches a neighbouring hypha. The columella is spherical to oblong, or sometimes slightly pear-shaped, 55-22 × 50-20 μ, the longer diameter being the vertical one (Fig. 20). There is a basal collar. The spores vary in

Fig. 21.—*Mucor erectus*. Spores. × 1,400.

Fig. 22.—*Mucor erectus*. Zygospore. × 640.

size and shape (Fig. 21), 11-7 × 6-3 μ (average 7 × 5 μ; some are almost spherical, 2-3 μ in diameter). In the mass they are grey in colour.

The zygospores and azygospores were produced in cultures on potato and on bread, but on no other media. They are ornamented with star-like thickenings of a darker red-brown than the rest of the surface (Fig. 22). Good specimens of zygospores are 90 μ in

diameter; the smaller ones average about 60-65 μ. The azygospores are generally unequally developed, one of the pair being often aborted; they are 60-70 μ in diameter when well developed.

The zygospores have not been germinated, neither has it been as yet determined whether this species is homo- or heterothallic.

On heating in sulphuric acid all parts of the fungus are dissolved, excepting the exospore of the zygo- and azygospores. Similar treatment with hydrochloric acid is survived also by the spores and hyphae, sometimes by the columellae (but these last are rendered very brittle). Caustic potash does not produce any marked immediate effect on any parts.

This species dislikes high temperatures; the spores appear to be killed by exposure to 26°-38° C. At room temperature and out-of-doors the fungus does well.

Growth was luxuriant on most media; on potato and bread, as stated, zygospores are produced The fungus would not grow on pollen, and in most cases grew poorly on honey media; it did not flourish on pollen decoction gelatine or on apple. Gelatine is liquefied, and the resulting liquid is often coloured a tawny yellow (about the colour of Flemming's fluid). A culture on bouillon agar was also coloured yellow. Acid is probably not produced.

The description here given agrees in most points with that given by Fischer for *Mucor erectus* (10, p. 197).[1] The principal difference is that Fischer describes the spores as uniform in shape (" gleichgestaltet "), whereas in my specimens there is a decided tendency to variableness in the form of the spores. He also gives the zygospore diameter as 40-65 μ. Otherwise the agreement is close.

Fischer mentions echinulate gemmae, which did not occur in my cultures; also a spherical yeast-form. This latter, it is believed, was met with occasionally in the earlier course of the research; but has not been observed lately.

Pericystis alvei, Betts.

This species is apparently a true bee-hive fungus, occurring only on the pollen stored in the combs, and adapted to life in the hive. The appearance, both of the mycelium (Fig. 23), and of the dark-green cysts (Fig. 24) containing numerous sperical spores (Fig. 25), is very characteristic and peculiar, and makes the identification of the fungus an easy matter. The process of development of the

[1] The dimensions given by Fischer for *M. erectus* are greater than those in Bainier's original description (see *10*, p. 197).

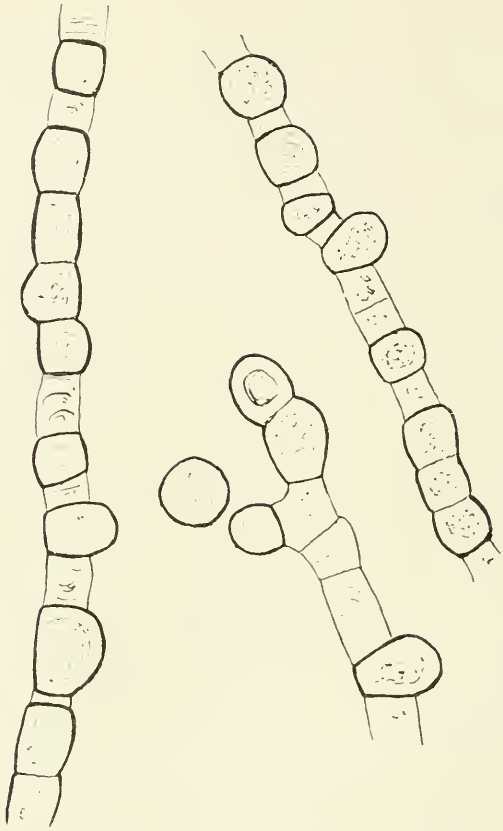

Fig. 23.—*Pericystis alvei.* Hyphae and chlamydospores. × 1,400.

Fig. 24.—*Pericystis alvei.* Cyst. × 1,400.

cysts, and the probable life-history, have been dealt with elsewhere (4).

Pericystis alvei is one of the most frequent of the bee-hive fungi, and is probably the species chiefly responsible for the white "pollen-mould" so well known to bee-keepers.

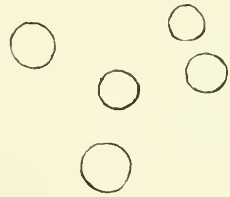

Fig. 25.—*Pericystis alvei*. Cyst spores. × 1,400.

It would be of interest to ascertain the distribution of this fungus; whether it is confined to the British Isles or is of world-wide occurrence. The type specimens were collected in North-western Surrey.

As far as could be ascertained by means of cultures on litmus media, no acid is produced by this species.

Oospora favorum, Berkeley and Broome.

The type specimen having disappeared from the Berkeley Herbarium, I was unable to make a direct comparison with it of my

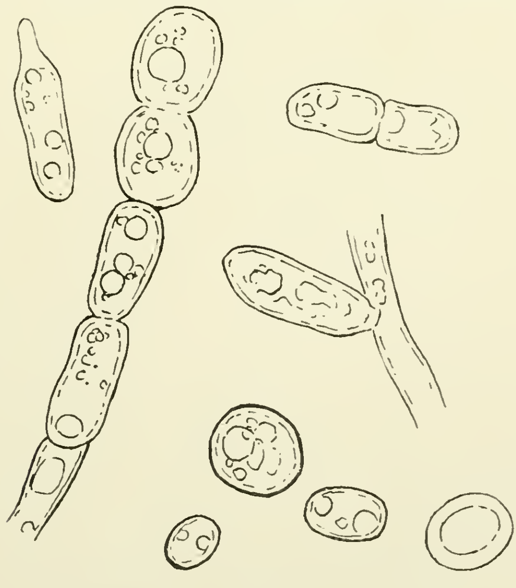

Fig. 26.—*Oospora favorum*. Conidia and torulose cells. × 1,400.

specimens; but there seems little doubt that the fungus here described is identical with Berkeley and Broome's species.[1]

Oospora favorum is found chiefly on old brood-combs, on the wax of the cocoons; it sometimes also occurs on the stored pollen. On wax or cocoons it has the appearance described by Berkeley and Broome—small yellow tufts. On pollen it forms a yellow wrinkled growth, having a velvety surface owing to the presence of numerous conidiophores, which consist of a short hyphae bearing chains of conidia. The hyphae are septate, and have a strong tendency to torulose growth, particularly in damp cultures. In such cultures the resemblance to a yeast is striking; no true hyphae are developed, but only strings of torulose cells, which are often indistinguishable from

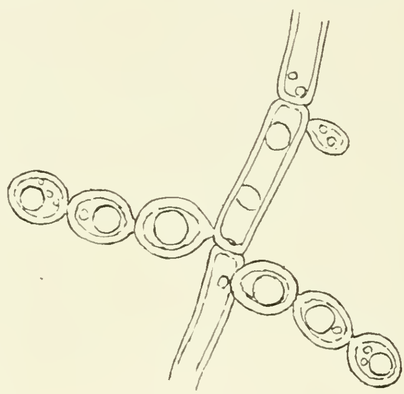

Fig. 27.—*Oospora favorum*. Conidia. × 1,400.

the conidia, save by their more irregular and elongated shape (Fig. 23). The fusiform bodies noticed by Berkeley and Broome were probably cells of this kind.

The conidia are borne in short, simple or branched chains (Figs. 27, 28). They are spherical when young, becoming larger and subglobose or oval as they grow older. The filiform conidia seen by Massee (22) were perhaps of that form in consequence of having been long dried. The size of the conidia varies. In specimens from a culture on pollen they measured $6 \times 4\ \mu$; but on various artificial media they range from $8 \times 6\ \mu$ (or even $10 \times 7\ \mu$) to $7 \times 5\ \mu$. Owing to the difficulty of distinguishing between torulose hyphal cells and conidia, it is impossible to be certain of the maximum dimensions.

The fungus is at first white, later yellow. In some cultures (*e.g.*, some of those on pollen and on honey media) this is the final colour.

[1] My thanks are due to Miss Wakefield for her kindness in searching for the type specimen in the Berkeley Herbarium.

In others, however, it deepens to a dull mustard colour, olive-yellow, or (in many cases) a deep brown (almost black). The torulose hyphae undergo this change as well as the conidia.

The alteration in colour is accompanied by a progressive alteration in the chemical constitution of the cell-walls. Young conidia (that is, from white or light yellow cultures) are dissolved in sulphuric acid, often without the application of heat. After a culture has reached the dull mustard-yellow or light olive stage, however, the conidia are not destroyed by heating in sulphuric acid. Similar results are obtained with hydrochloric acid, except that the young conidia do not entirely disappear even on heating, but traces of them remain. Caustic potash solution does not appear to produce any marked effect on the conidia at any stage.

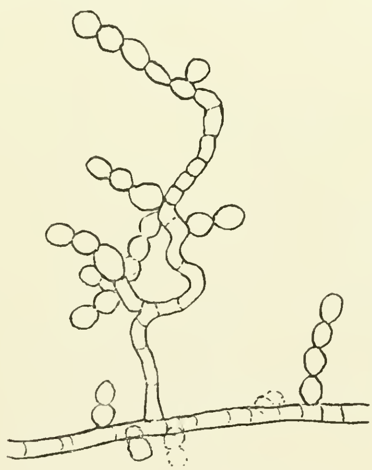

Fig. 28.—*Oospora favorum*. Conidiophore. × 640.

This species appears to be variable. I cultivated two varieties, derived originally from the same culture. One of these tended to colour and cuticularize earlier than the other, and to attain ultimately a darker colour. They were transferred to various media, and in nearly every case the difference referred to was apparent.

The results of the temperature-experiments were somewhat contradictory, and no certain conclusions can be drawn from them. The fungus did well at room temperature in all cases.

This species appears to do best on pollen; cultures on honey media were, however, fairly successful. Normal conidia were produced on fairly dry potato, in small quantity. On prune decoction media the growth is torulose. Gelatine is liquefied. From the results of cultures on litmus media it appears that acid is occasionally produced.

General Conclusions.

Of the foregoing twelve species, *Pericystis alvei* is probably a bee-hive fungus in the strict sense. This conclusion seems warranted by the frequency of its occurrence in hives, taken in conjunction with the fact that it has not been observed elsewhere; and is confirmed by what is known as to its requirements in the way of temperature and pabulum (4).

Of the others, *Oospora favorum* is very probably also confined to bee-hives; it is not a common species. *Gymnoascus setosus* seems to be adapted to life in the hive, judging by its luxuriant growth in dead stocks, and by its unwillingness to grow on artificial media. It has been previously recorded from the nests of other Hymenoptera (8, p. 571). *Aspergillus nidulans* was originally found by Eidam on a humble-bee's nest; it is one of the less common of the bee-hive fungi, however, and has only once been observed to grow luxuriantly on a mouldy comb, being generally found in but small quantity, when present at all. It is probably absent from healthy stocks.

Mucor erectus is chiefly, if not exclusively, found on dead bees. It is probably not able to flourish on the combs.

Sordaria fimicola and *Gymnoascus ruber* are coprophilous; the former, as has been stated, may very likely be carried into the hive by bees visiting stagnant water. *G. ruber* has only once been observed; its spores were probably adhering to some of the bees of the cluster, and developed on their bodies after death.

Nothing is known as to the probable original source of *Eremascus fertilis*. Stoppel found it on paper which had been soaked in rum and used to cover some apple and currant jelly pots, and it seems capable of normal growth on various media; hence can hardly be considered specially a bee-hive fungus.

Aspergillus glaucus and *Penicillium crustaceum* are ubiquitous, and their presence in the hive needs no explanation. It is possible that the same considerations may to some extent apply to the two species of *Citromyces*.

In conclusion, my thanks are due to Dr. Rendle for permission to use the library at the Cryptogamic Herbarium, British Museum; to Miss A. Lorrain Smith for her unfailing kindness in advising me on systematic and other points; and to Mr. J. Ramsbottom for much kind assistance in naming the fungi. I also desire to thank Mr. T. W. Cowan for valuable information as to previous work on the bee-hive fungi, and for the loan of several periodicals cited in this paper.

The figures illustrating this paper were drawn from fresh material with the aid of a camera lucida, and the magnification is approximately × 1,400 except where otherwise stated.

SUMMARY.

1. An account is given of the previous work that has been done on the fungi present in bee-hives; and some questions arising from these records are discussed.

2. A general description of the conditions prevailing in the hive, and of the distribution of fungous growth in it, are given.

3. The following twelve fungi are described:—

   Probably confined to the hive:
      Pericystis alvei, *Oospora favorum*.

   Adapted to hive-life, but not confined to this habitat:
      Gymnoascus setosus; *Eremascus fertilis* (perhaps).

   Common, but not specially adapted to life in the hive:
      Penicillium crustaceum, *Aspergillus glaucus*, *Citromyces subtilis*, *C. glaber*, *Mucor erectus*.

   Occasionally present:
      Aspergillus nidulans, *Sordaria fimicola*, *Gymnoascus ruber*.

LITERATURE CITED.

1. **Bainier, G., and Sartory, A.**—Étude de quelques *Citromyces* nouveaux. Bull. de la Soc. Mycol. de France, 1912, xxviii, Fasc. 1.
2. **Bennemann, E., and Hübner, E.**—Ueber Mucorine. Bienen-Zeitung, xxxvii, 1881, p. 7.
3. **Berkeley, M. J., and Broome, C. E.**—Notices of British Fungi. Ann. and Mag. Nat. Hist., 1854, Series 2, xiii.
4. **Betts, A. D.**—A Bee-Hive Fungus, *Pericystis alvei*, Gen. et Sp. Nov. Ann. Bot., 1912, xxvi, p. 795.
5. **Cooke, M. C.**—Handbook of British Fungi, 1871.
6. **Cowan, T. W.**—Notes on a New Bee-Disease. British Bee Journal, 1881-2, ix, p. 33.
7. **Crookshank, E. M.**—Textbook of Bacteriology. 1896, p. 588.
8. **Dale, E.**—Observations on Gymnoascaceæ. Ann. Bot., 1903, xvii, p. 571.
9. **Duggar, B. M.**—Fungous Diseases of Plants. 1909, p. 24.
10. **Fischer, A.**—in Rabenhorst's Kryptogamen-Flora. Bd. i, Abt. 4.
11. **Graham-Smith, G. S.**—Report on the Isle of Wight Bee-Disease (Microsporidiosis), Section i. Supplement No. 8, Journ. Board of Agric., May, 1912.

12. **Graham-Smith, G. S., and Bullamore, G. W.**—Report on the Isle of Wight Bee-Disease, Section vi, B., p. 85.

13. **Hein, W.**—Märkische Bienen-Zeitung, Jan. 1912, ii.

14. **Higgins, H.**—On the Death of the Common Hive Bee, supposed to be occasioned by a parasitic Fungus. Journ. Proc. Linn. Soc. (Zool.), 1858, iii.

15. **Hoffmann, H.**—Ueber Pilze im Bienenmagen. Hedwigia, 1857, i, No. 19.

16. **Howard, W. R.**—American Bee Journal, 1896, xxxvi, p. 577.

17. **Howard, W. R.**—Gleanings in Bee-Culture, 1900, xxviii, p. 121.

18. **Lafar, F.**—Technical Mycology. English trans., ii, pt. 2.

19. **Lindau, G.**—in Rabenhorst's Kryptogamen-Flora. Bd. i, Abt. 8.

20. **Maassen, A.**—Mitt. aus d. Kais. Biol. Anstalt. f. Land-u. Forstwirtschaft, June, 1906, Heft 2.

21. **Mangin, L.**—Qu'est ce que l'Aspergillus glaucus? Ann. Sci. Nat., 1909, Series 9, x.

22. **Massee, G.**—British Fungus Flora, 1893, iii, p. 279.

23. **Massee, G., and Salmon, E. S.**—Ann. Bot. xvi, 1902, p. 63.

24. **Preuss.**—Bienen-Zeitung, 1869, xxv, p. 163.

25. **Saccardo, P. A.**—Sylloge Fungorum.

26. **Saito, K.**—Untersuchungen über die atmosphaerischen Pilzkeime. Journ. Sci. Coll. Imp. Univ. Tokio, Vol. xviii, Art. 5.

27. **Stoppel, R.**—*Eremascus fertilis*, n. s. Flora, 1907, xcvii, Heft 3.

28. **Wehmer, C.**—Beiträge zur Kenntniss einheimischer Pilze. I. Zwei neue Schimmelpilze als Erreger einer Citronensaure-Gährung. 1893.

29. **Winter, G.**—in Rabenhorst's Kryptogamen-Flora. Bd. i, Abt. 2.

30. **Zorn and Hallier.**—Untersuchungen uber die Pilze, welche die Faulbrut der Bienen erzeugen. Zeitschr. f. Parasitenkunde, 1870, ii, p. 137.

PRELIMINARY STUDIES ON THE BIOLOGY OF THE BEDBUG, *CIMEX LECTULARIUS*, LINN.

II.—Facts obtained Concerning the Duration of its Different Stages.*

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WITH 11 TABLES.

INTRODUCTION.

By keeping in confinement and feeding the descendants of a single female, captured in a stateroom of a steamboat plying on the Ohio River between Cincinnati, Ohio and Louisville, Kentucky, at 11.30 p.m., August 7, 1907, I have been able to rear, during the winter of 1907-1908, and the spring of 1908, three successive generations of this insect, tending to show that it does not hybernate where the conditions are such as to allow it to breed, and that breeding is continuous unless interrupted by lack of food, or during the winter, by low temperature. Hence, the bedbug has at the least three or four generations during a calendar year. Moreover, I have been able to mate the adults and keep a record of the rate of deposition, and at the same time to record the length of life of the parents when reproducing. Other important observations will be brought out in a following and concluding paper. During these observations no evidence of parthenogenesis was observed. The insects were fed on human blood throughout. This paper records only those data which have been obtained concerning the duration of the different stadia. I also sum up here the result of such observations as it has been possible for me to make concerning the relation of temperature to development in insects, and any bearing which this may have on the procedures of the economic entomologist.

The bedbug is a creature about which there has been written much nonsense, and I have pointed out previously how this has been handed down even to modern times. Our present knowledge of it, however, shows that it is an insect adapted to a parasitic

* Part I appeared in this Journal in 1910, vol. v, pt. 3, pp. 88-91, Tables I and II.

life upon human beings, and that it is quite active, freely moving from place to place as circumstances require, able to tide over for quite a time, if necessary to do without food, and quite willing to feed upon other warm-blooded animals upon occasion. It is as much at home in our artificially heated houses during the winter as at other times, and continues to be a highly successful animal, dependent directly upon man, and forming more or less a blot upon and a menace to modern civilization, more especially as it exists in huge cities.

1.—Duration of the Egg Stadium.

At Urbana, Illinois, U.S.A., during the first part of the year 1908, whenever possible, fertile eggs of known age were obtained and kept under observation, in order to determine accurately the time occupied for embryonic development. These eggs were those deposited by the mating pairs under observation, and as soon as deposited were removed and confined in a small glass vial plugged with cotton and kept in a dark drawer of a table. Every lot was treated in the same manner, with one or two exceptions as noted. Table I summarizes.

The temperatures shown in Table I are artificial, and thus there is no gradual decrease in the duration of the stage as the date advances. The "effective" temperatures are those above 43° F. The daily average "effective" temperature is highest when the stage is shortest—witness lot No. 1—and lowest when the stage is highest, as in lots No. 3, 13 and 14. It is also true that in lots showing the same actual duration of the stage, are shown different average "effective" temperatures, as in lots No. 6, 20 and 22, 18 and 19, 15, 17 and 23, 9 and 15, 10 and 11, and 2 and 16; these differences in "effective" temperatures are, however, mostly within what may be called the margin of error, which is about 1.5 degrees. Some of the lots agree very closely.

If arranged according to the duration of the stadium, the relations of the factors involved are more apparent. This is done in Table II.

The "effective" temperatures should be reduced to total temperatures. The relation of development to temperature is, speaking generally, a definite one, the rate of development increasing with the rise in temperature and decreasing with its fall. This relation is adaptive and holds for all living things. No organism can develop below a certain temperature, and there is also a mini-

mum temperature at which development will begin, which is more or less a definite specific or even racial characteristic, varying with the nature of the organism; this is well illustrated by the varying times at the same temperature and conditions of moisture which different species of seeds require to germinate, and the varying times at which development is renewed in the spring by different organisms; and it is also true for maxim temperatures, as is well illustrated by different forms of bacteria, some being adapted to high temperatures, others ceasing to develop at comparatively low temperatures. Thus, in all species of organisms development is specifically adapted to certain definite ranges of temperature, commencing at a more or less definite minimum, proceeding normally at an optimum, and decreasing to zero at a more or less definite maximum for any particular species. And this is true of life itself as manifested in the different species.[1]

For insects it has been shown in the case of the Colorado Potato Beetle (*Leptinotarsa* 10-*liniata*, Say.) how the duration of the egg stage decreases with the increase of the temperature; but the effects of temperature stop here. As soon as the locality varied, though there was the same increase of development with the increasing temperature, it did not occur in the same relative way. Thus, in the comparatively hotter climate of Georgia, in the last week of May and the first week of June, the stage ranged from five days fourteen hours to four days two hours with a temperature of 33.2° for the first, and 38.9° for the last (neither maximum nor minimum); in the colder climate of Ohio, in the last two weeks of June the stage ranged from nine days sixteen hours to four days fifteen hours, and the temperature from 22.42° to 33.85°, and in Illinois the following year, from June 5 to June 18 the stage ranged from seven days nine hours to five days, the variation irregular, the longest and shortest stage occurring on June 16 and 9 respectively; the temperature ranging from 24.4° to 34.2°, corresponding with the extremes in duration of the stage.

It seems, therefore, that general climatic conditions have something to do with the rate of development, modifying the effects of the temperature. For a stage of four days fifteen hours in Georgia,

[1] Instances of this are common in nature. A sudden cold spell will often kill some species in great numbers, while others are unaffected; heat will do the same. As an example, I might mention certain Medusae; tropical forms are killed very quickly by certain lower temperatures which would not affect a temperate species; on the other hand, they can survive higher temperatures than can temperate forms. This also holds for individuals of species ranging through the heat zones, as in *Aurellia aurita*.

there was required a daily temperature of 40.5° (above 43° June 8), in Ohio a temperature of 33.85° (June 23), and in Illinois one of 35.64° (July 19). Other equal periods showed nearly the same relations.

Now, take the case of embryonic development in other insect species. The chrysomelid, *Gastroidea cyanea*, Melsheimer, has an egg stage in Ohio of four days, 10, 12 and 8½ hours, the average daily temperature being 31.5°, 36° and 37°. In the same place on July 12, the eggs of the potato beetle were hatching at the same rate of development (4 days 10 hours) at a temperature of 36°; on July 11, 4 days 4 hours, at a temperature of 37°, agreeing tolerably well. But the differences of a few days can be ignored, so combining, the *Gastroidea* has a stage of 4 days 10 hours, at a temperature of 34.8°; *Leptinotarsa*, 4 days 7 hours, at a temperature of 36.5°, still agreeing. This case, however, must be coincidental, for we have still other records which tell a different tale; none, however, like this where two species are compared side by side, with the exception of one other beetle experimented with in the same Ohio place, and a dipteron. The beetle was the coccinellid, *Megilla maculata*, DeGeer. I find that on June 8 the egg stage was seven and a third days, at a temperature of 20.1°, and on June 10 five days twenty-three hours, at a temperature of 22.0°. On June 10, in the case of the Colorado Potato Beetle, the stage was nine days sixteen hours, at a temperature of 22.4°. There is certainly little agreement between these two. Also with the coccinellid, at a temperature of 20.2° (mean daily), the stage was six and a quarter days, when ending on May 30, 1907, but seven and a third when ending on June 8; certainly not what would be expected were the rate of development due entirely to the amount of heat to which the embryo is exposed. The dipteron referred to was *Pseudopyrellia cornicina*, Fabr., whose egg stage was about one day on August 21, when the mean daily temperature was 31.8°. Compare this with the stage of four days twenty hours for the *Leptinotarsa*, when the temperature was 31.9° (August 2), and there can be little doubt but that the rate of development is specific and adaptive. This is a matter of common observation.

During 1909, in Illinois, U.S.A., some observations were made in respect to this with two species of wasps, *Polistes pallipes*, St. Fargeau, and *Sceliphron cementarius*, Drury. In a single nest of the former, the egg stage decreased as it became warmer from about twenty-two days to about eleven or twelve days, June 14 and 25. In the same room eggs of the Sceliphron were hatching after slightly

over three days (June 11 and 12), and $2\frac{1}{2}$ days (June 25). As it became warmer the stage lessened by another day or nearly. Now, it is certain that the temperatures to which these two species were exposed were practically the same. In the common *Musca domestica* it is a well-known fact that the very short egg stage still further decreases at higher temperatures than usual in the summer, but I do not know of any way in which it may be predicted in any locality of which the average temperature is known. In the same place in Illinois in 1909, the eggs of *Sanninoidea exitiosa* (Say.) in late August did not hatch until after 8.3 days, when the eggs of the Sceliphron were hatching after slightly over two.

In Table II the egg stage of the bedbug is shown to vary similarly to that of other insects; as the temperatures increased the stage decreased; taking averages, the temperatures do not overlap for half-day groups, but this fact does not hold for insects under more natural conditions. The Cimex eggs were indoors, and so confined as not to be very much exposed to moist atmospheres. Another observation made in connection with this insect is of interest in this connection. Once I took twelve eggs which had been deposited at about seven o'clock, February 29 (1908), in a warm room, and divided them into two equal lots; each lot was then placed in a vial, alike for both, and one kept at a high temperature, in a warm room where originally deposited, while the other was placed at a lower temperature in a slightly heated greenhouse. Unfortunately, the temperatures are not now available to me but the relations are well shown—the six eggs kept in the higher temperature hatched after the mean time of seven and two-third days, all hatching within thirteen hours; the other six kept in the lower temperature did not hatch until after a mean time of thirteen days, ranging from eleven to fifteen days. (The variation in the length of the period of hatching seemingly increases as the temperature lowers from the optimum).

Enough observations have been cited to show that the relation of development to temperature in insects is a specific one, varying for the species, at least those of different genera. This must be true for all insects, though I am not able to give many other facts of this nature which I had gathered from the literature.

While making observations upon a beetle, I was much struck with the fact that in some individuals one stage of larval development might be much shorter than the mean, and the next stage longer, or in other words, the larval stage would vary considerably while the whole period of larval development remained unchanged

or would not depart much from the mean. One stage made up what the other lost. It would seem, then, that it would not be safe to draw conclusions from facts based upon but one stage of development, such as has been done, since the impulse set up in one stage may continue over into the next and so on. The whole duration of development may be an expression of the sum of forces acting upon each stage. It thus becomes necessary to examine similar facts in regard to the whole period of development, and accordingly I set about this so far as my own data and the now very poor access to literature will allow.

I take first the case of the Colorado Potato Beetle. The data available to me show that the means of the whole stage of development agree tolerably well in three places, namely, Georgia, Ohio, and Illinois. In the former place (1906) the period of development from deposition of the egg to the appearance of the adult was twenty-eight days; in Ohio it was slightly over twenty-seven, and in Illinois twenty-eight and nine-tenths, the temperatures being respectively 35.5°, 32.5° and 32.8°. In Ohio the *Gastroidea* passed through its development in a period of eighteen days at a daily mean temperature of about 36° F.; the *Megilla* in thirty-four days at a mean temperature of about 22°; the *Pseudopyrellia* in thirteen and a half days at a temperature of 32°. Certainly these rates of development are specific.[1]

In Illinois, the pteromalid, *Nasonia brevicornis,* Ashmead, in the last half of September passed through its development in a period of sixteen days at a temperature of about 32.5°; at about the same time another pteromalid, *Muscidifurax raptor,* Girault and Sanders, required an average of about twenty days. During 1904, in Texas, *Trichogramma minutum,* Riley, required an average of about twelve days for its development at a temperature of about 29°. The only comparable data are those for the potato beetle which seem to show that the duration of the cycle for the same species is about the same in different localities. But even if this should hold in this case other cases can be given as exceptions.[2]

[1] This is true for plants. I may mention an instance. From plant to harvest or fruiting, beans require only about fifty days, while peanuts under the same conditions require about a hundred and forty; also annual and biennial plants.

[2] For instance, *Sanninoidea exitiosa* in the northern and southern portions of the United States. *Tibicen septendecim,* Linnaeus, which requires seventeen years for its development, is a notable example of how the cycle of development may vary in different sections of the same country, since it may appear after thirteen years. It is also a striking example of how local climatic influences change the time of appearance of an insect. Otherwise it would appear over all the country the same year.

We must now attempt to explain what has been meant by the theory of effective temperatures.

As I understand it, entomologists obtained their ideas of this theory from C. Hart Merriam, who, I believe, postulated that no life began development until the daily mean temperature had risen above forty-three degrees of Fahrenheit. Upon what observations this was based I do not know, nor am I able to get at many facts bearing on it. All mean heat over that temperature was held by Merriam to be *effective*, that is, acting upon all development; no development occurred below a mean temperature of 43°.[1] Economic entomologists have attempted to use the theory prophetically, in the sense that they have tried to predict through it the duration of cycles of development in different latitudes and at different altitudes, from data collected at one place in regard to the relations of temperature to the development; also to predict the commencement of activity by insects of economic importance. This relation to temperature was rightly held to be a specific characteristic from the first. But so far I have failed to see that the theory has been of any practical value over large areas or even applicable. Its practical value would be undoubted could it be shown that it is applicable. But in the first place entomologists have been mistaken, by attempting to make some facts gathered by them fit into the theory. In one case, the inception of development in a beetle has been determined by taking the temperature at which the adults ceased active movement, but this is certainly an obscure relation to me. It seems that such a method would tend to show only the probable temperature at which hybernation would commence, but perhaps, more likely, only that a certain numbness had followed from exposure to low temperature. Activity in the adult has certainly very little direct relation to the inception and rate of development—exceedingly active insects, like dragon flies, develop very slowly, and true flies very quickly; some insects are active throughout the winter, but their development ceases; numerous adult insects emerge from hybernation before their development commences and by the time they have mated and deposited eggs, or by the time that oogenesis has commenced the temperature has risen considerably, or much time has

[1] Deep sea animals live in very low temperatures, below forty degrees at least and some pelagic eggs of fishes are suspended at considerable depths in the ocean, but I believe development is unknown below forty-three degrees of Fahrenheit. The eggs of chickens, I believe, cease development at 68° and die. However, it must not be forgotten that some simple plants live on the snow at the top of high mountains, coloring it.

elapsed. In his journal, Darwin records the fact that at Bahia Blanca, in South America, animals were hybernating when the mean temperature stood at 51° F.; in the course of eleven days emergence from hybernation was general, and the mean temperature had risen only seven degrees; yet the amount of heat was greater. At Monte Video the same naturalist observed that when the temperature stood at 50°, many animals were hybernating; here the lowest recorded temperature was 41°. I have seen hybernation general at a temperature much higher than 43° mean.[1] "This shows how nicely the stimulus required to arouse hybernating animals is governed by the usual climate of the district, and not by the absolute heat." Thus, it would seem impossible to connect inception of development with the emergence from hybernation or aestivation or with adult activity. Just what stimulus causes animals to go into hybernation will vary with the animal, the climate and the environment.

In some insects hybernation will commence in the summer as soon as their special food supply becomes scarce; this has certainly little to do with the temperature. In the tropics, also in droughts, many animals hybernate. Also the duration of the period of development is certainly not always connected with the temperature. *Malacosoma americana* (Fabricius) in Virginia hatches early in the spring at the first rise in temperature (8 days before hatching occurred out-of-doors, a few hours' exposure of the eggs in a warm room induced hatching), comes to maturity before summer has arrived, and deposits its eggs just as summer has begun; yet the eggs do not hatch, in the great majority of instances at least, until the following spring, in spite of the greater quantity of heat to which they are exposed in the summer just arrived. Here is a developmental cycle prolonged for a whole year without any relation, certainly, to temperature. The peach borer, *Sanninoidea exitiosa* (Say.), is just as late in coming to maturity in the southern United States as in the northern, though if temperature counted it should be much earlier, as was thought to be the case for many years by economic entomologists. Tower has shown how certain climatic factors are able to change, in the Colorado Potato Beetle, the generative habit.[2] We may go on multiplying instances.

[1] *Anthonomus grandis* hybernates in the winter in Texas when the average mean temperature is much above 45 degrees.

[2] I have myself observed this, in the case of a *Conotrachelus* of great economic importance in the United States; the second generation of adults, though matured in the summer, hybernate without reproduction. In a very moist and hot atmosphere, however, they have been observed to change this invariable habit and produce eggs for another generation.

In the second place the theory of Merriam has no bearing on economic entomology at all, since instead of saying forty-three degrees, we may say thirty or twenty or any number without changing the fact that activity commences in various insects at various times, according to their nature and their immediate environment.[1]

I think it is plain that the foregoing facts will support only these conclusions, namely, (1) That the relation of development to temperature is a specific one. (2) That, other things being equal, the relation implies an increase in rate of development with the increase of temperature. (3) That it is not possible to predict what this increase will be under the higher or lower temperatures of different climates, as in the case of the Sanninoidea mentioned; the predictions must be preceded by experience. (4) That the temperature at which development commences, flourishes and begins to cease (minimum, optimum and maximum), is also specific, and there is not, therefore, any foundation for such a theory as that of effective temperatures of Merriam, as understood by economic entomologists in America. The theory as stated by Merriam may stand,[2] but has no bearing on economic entomology.

All life responds to temperature; if it were not for heat, indeed, no life could exist; nor if heat were too great. But between the maximum and minimum there is a range in temperature to which all organisms have adapted themselves. Cold-blooded animals require high temperature for development, whilst warm-blooded animals can maintain their own temperatures without so much dependence upon the seasons. Thus, in the latter, embryonic development proceeds in winter or summer, and its duration is correlated with size rather than with temperature; but birds, whose body maintains the highest temperature among the higher animals, have very short periods of development, shortest in humming birds. And in the winter development ceases. Also cold-blooded animals (of necessity) become dormant during winter; reproduction cannot proceed until the temperatures are high enough to allow development of the young. Merriam's theory may or may not be true, but true or not, it has no meaning for the economic entomologist; because nothing predictable issues from the fact that no development occurs under a mean temperature of 43° F. The important points for the economic entomologist are that the rate of development in insects

[1] Nor does the duration of cycles have any more relation than Merriam's so-called theory.

[2] It cannot be true if taken to mean that development in all organisms has its inception at 43° F.

and their cycles is an adaptation to the environment; in the same species the response is due to heredity plus stimuli, and will vary in point of time with the varying times at which these stimuli will appear in different localities; in species unrelated, the variation will vary according to their natures. This is an obvious fact, since if not true in the same locality, or for that matter over the entire earth, we would find all organisms with the same periods of growth and the same cycles of development. All organic life would then move in one gigantic, "eternal," unchanging, harmonic wave of growth and reproduction.

I have diverged this much, in order to sum up my observations on the relation of development to temperature in insects and their final bearing upon the procedures of the economic entomologist. The argument may still be advanced, however, that, providing all the facts concerning development and generation of an important economic insect have been obtained in a number of different localities, it is possible at least over small areas like the counties of a state in America, to predict when the insect will become active in any following year. But the next year or the following one may vary considerably, and even though means are taken, I defy an economic entomologist to show that he can predict for a locality of which he is ignorant, the time at which activity will begin during any particular spring. He may warn the farmer that such and such a time is probable, but the fact still remains that the man on the land must observe for himself where to begin operations on his particular piece of land, and if that is so, Merriam's theory has no practical bearing in applied entomology and should be omitted, as being irrelevant, from the discussions of the economic entomologist.[1]

2.—Duration of the Postembryonic Stadia.

The following tables summarise the facts obtained in regard to this. Some of these facts have already been published in Part I. of this series, and reference is made to them instead of repeating here. Only those insects which were reared under nearly normal conditions are included.

3.—Duration of the Adult Stadium.

This includes only those adults reared from the egg and kept under as natural conditions as possible, allowed to mate and fed

[1] In this connection I should call attention to the striking differences in the time of flowering of different varieties of the same plant at the same place; notably, the varieties of apple in an orchard.

regularly, and to repletion or engorgement. All those of one generation were fed at the same time. Table V. summarises.

In Table V *a*, the few facts gathered in regard to captured adults, their previous history unknown, but involving at least some food and reproduction, are given; they were fed irregularly after capture, but allowed to engorge each time.

It is interesting to compare the duration of life shown on Table V *a* with that shown in the summary on Table VI, where the adults were fed regularly and mated, but when immature were not allowed to engorge or satisfy their hunger (Table VI). Upon reaching maturity, they were allowed to engorge at every meal. The poor nourishment during immaturity seems to have had little or no effect in these few cases in decreasing length of life and power in adult life.

4.—The Effects of Starvation on the Duration of Life.

(1) *Postembryonic Stadia*.—From time to time, individuals of the postembryonic stadia have been kept and not allowed access to food or even moisture, simply being placed in a small glass vial or a card-board box containing a piece of filter paper for a perch. The data obtained, though not large, must be divided into two groupings, based upon the origin of the material and its previous history. The first grouping includes those nymphs hatched from eggs obtained from females in captivity and starved from birth; necessarily, all of these were of the first stadium. The second, nymphs whose previous history is unknown, but which certainly had had access to more or less food before capture. This second grouping therefore comprises all postembryonic stadia following birth which had had access to a host one or more times.

Table VII gives in concise form the data for the first group.

The maximum length of life was forty-two days, the minimum sixteen days; the latter does not show in the table where the mean minimum was one day longer. Three additional records overlooked when making the table are added here. Five nymphs, hatching October 20, 1905, from eggs deposited in confinement by a female taken at Washington, D.C., died at the mean time of November 20, 1905, or just a full month after birth; two others, of the same origin, hatching October 17, 1905, and isolated, died within a month. Three nymphs, hatching at Washington, D.C., October 17, 1905, were still alive by November 18, 1905, dying soon afterward.

Table VIII gives the data for the second grouping.

As age advances, the duration increases. This is indicated also by the next Table (IX). The fifth stage lived twice as long as the second, but then the latter were not full-fed when captured, which may account for the difference. The facts are too few.

Additional : A pallid nymph captured by shaking iron beds in a cheap lodging house, Chicago, September 15, 1910, died the following day. It was in the third stadium.

(2) *Adult Stadium.*—All the facts obtained from time to time concerning the duration of adult life when starving are summed up in Table IX.

No records have thus far been made for adults starved from maturity.

CORRECTIONS TO PART I.

The following errors occurred in printing part I of this series :—

Page 90, line 6, for different *read* definite.

Page 90, line 32, for consisting of the control lot of *read* consisting, with the control lot, of.

TABLE I.

Duration of Embryonic Development in Cimex lectularius, for Different Generations and Dates, 1908.

Lot. No.	Source.	No. Eggs.	Deposited.			Hatched.			Duration.		"Effective" Temperature, Degrees Fahr. Daily Average.
			Month.	Day.	Time.	Month.	Day.	Time.	Days.	Hours.	
1	Gen. I, Pair No. 1	10	January	10	7 a.m.	January	16	4 a.m. (a)	5	21	45.76 Degrees
2		1	,,	19	7 p.m.	,,	28	5 a.m.	8	10	40.76 ,,
3		1	,,	25	10 p.m.	February	4	7 a.m.	9	9	39.22 ,,
4		3	February	1	6 p.m.	,,	11	8 p.m. (b)	10	2	(c)
5	♀ No. 8	1	,,	23	7.30 p.m.	March	1	7 a.m.	6	11½	43.50 ,,
6	Pair No. 4	1	,,	25	noon.	,,	3	7 a.m.	6	19	43.33 ,,
7	♀ No. 4	6	,,	27	6 a.m.	,,	5	2.30 p.m. (d)	7	8½	42.51 ,,
8	♀'s 1 and 4	2	,,	27	11 a.m.	,,	5	7.30 p.m.	7	8½	42.51 ,,
9	♀ No. 9	2	,,	27	6 p.m.	,,	6	6 a.m.	7	12	42.29 ,,
10	♀'s 4 and 9	2	,,	28	noon.	,,	7	6 a.m.	7	18	42.32 ,,
11	♀ No. 9	3	,,	28	6 p.m.	,,	7	11 a.m.	7	17	42.30 ,,
12	♀ No 9	1	,,	29	7 p.m.	,,	9	7 a.m.	8	12	41.04 ,,
13	♀ No. 4	6	March	6	6 a.m.	,,	15	10 a.m.	9	4	39.66 ,,
14	♀'s 1, 4 and 9	4	,,	7	10.30 p.m.	,,	16	3 p.m.	8	16½	39.70 ,,
15	♀'s 1, 8 and 9	3	,,	16	10 p.m.	,,	24	9.30 a.m.	7	11½	41.81 ,,
16	Gen. II, Mixed	5	,,	19	8.30 p.m.	,,	28	7 a.m.	8	10½	41.29 ,,
17	Pairs 1 and 3	4	,,	31	6 a.m.	April	7	4 p.m.	7	10	41.78 ,,
18	Pair No. 1	2	,,	31	1 p.m.	,,	7	8 p.m.	7	8	42.08 ,,
19	Pairs 1 and 3	4	April	2	5 a.m.	,,	9	1 p.m. (e)	7	8	42.97 ,,
20	Pair No. 1	1	,,	2	noon	,,	9	7 a.m.	6	19	43.21 ,,
21	Gen. I, ♀ No. 4	1	,,	2	5 p.m.	,,	9	11 p.m.	7	6	43.49 ,,
22	Gen. II, Pairs 1 and 3	2	,,	2	midnight	,,	9	8 p.m.	6	20	43.74 ,,
23	Pair No. 3	1	,,	15	10 p.m.	,,	23	9 a.m.	7	11	42.64 ,,
24	Gen. I, ♀ No. 9	1	,,	20	9.30 p.m.	,,	27	3 p.m.	6	17½	42.50 ,,

a. Average Time: 3 hatched at 4 p.m., January 15; 2 at noon and 5 at 4 p.m., January 16.
b. Chicago, Illinois; hotel.
c. Not obtained.
d. Average time: 1 at 10 a.m., 2 at 6 p.m., and 3 at 7 p.m.
e. Average time: 6 a.m., 3, 6 and 8 p.m.. April 9.

Three eggs deposited at Washington, D.C., by a recently captured female, on October 11, 1905, hatched on October 17 or after six days; they were in a warm room.

TABLE II.

Relations of the Length of the Egg Stage in Cimex lectularius to "Effective" Temperatures.

Lot No.	Duration of the Stage. Totals.		Daily Average "Effective" Temperatures. Degrees Fahr.	Averages of Half-day groups.	
	In Days.	Hours.			
1	5.875	141	45.76 Degrees	45.76° (5.5 to 6 days).	
5	6.479	155.5	43.50 ,,	43.50° (6.1 to 6.5 days).	
24	6.729	161.5	42.50 ,,		
6	6.79	163	43.33 ,,		
20	6.79	163	43.21 ,,	43.19° (6.6 to 7 days).	
22	6.83	164	43.74 ,,		
21	7.25	174	43.49 ,,		
18	7.33	176	42.08 ,,		
19	7.33	176	42.97 ,,		
7	7.35	176.5	42.51 ,,	42.34° (7.1 to 7.5 days).	
8	7.35	176.5	42.51 ,,		
17	7.416	178	41.78 ,,		
23	7.45	179	42.64 ,,		
15	7 479	179.5	40.81 ,,		
9	7.50	180	42.29 ,,		
11	7.708	185	42.30 ,,		
10	7.75	186	42.32 ,,	42.31° (7.6 to 8 days).	
2	8.416	202	40.76 ,,		
16	8.437	202.5	41.29 ,,	41.03° (8.1 to 8.5 days).	
12	8.50	204	41.04 ,,		
14	8.68	208.5	39.70 ,,	39.70° (8.6 to 9 days).	
13	9.16	220	39.66 ,,		
3	9.375	225	39.22 ,,	39 44° (9.1 to 9.5 days).	

Table III.

Duration of Postembryonic Stadia, the Food Supply Normal. Generation No. 2.

Stadium No.	1. Females.		2. Males.		3. Males.		4.	
	Moults.	Meals.	Moults.	Meals.	Moults.	Meals.	Moults.	Meals.
First.	6 a.m. Feb. 20.	p.m. Feb. 11. 7.30 p.m. Feb. 14.	6 a.m. Feb. 20.	7.30 p.m. Feb. 14	10 a m. Feb. 19.	p.m. Feb. 11. 7.30 p.m. Feb. 14.	3 p.m. Feb. 19.	p.m. Feb. 11. 7.30 p.m. Feb. 14.
Second.	6 a.m. Feb. 26.	7 p.m. Feb. 20. (b).	6 p.m. Feb. 25.	8 p.m. Feb. 20. (b).	6 a.m. Feb. 25.	7 p.m. Feb. 20. (b).	7 a.m. Feb. 25.	7 p.m. Feb. 20. (b).
Third.	9 a.m. Mar. 1.	6.30 p.m. Feb 26. (a).	7.30 a.m. Mar. 1.	6 p.m. Feb. 26. (a).	7 a.m. Mar. 1.	7 p.m. Feb. 26. (a).		(c).
Fourth.	6 a m. Mar. 10.	7.30 p.m. Mar. 1. 11.30 p.m. Mar. 4. (a) (= 11.30 p.m. Mar. 7).	6 p.m. Mar. 7, 1908.	7 p.m. Mar. 1. (a).	6 a.m. Mar. 7.	7 p.m. Mar. 1. (a).		
Fifth.	9 a.m. Mar. 18.	7 p.m. Mar. 11. (a).	9 a.m. Mar. 18.	(a). 7 p.m. Mar. 11. (a).	6 a.m. Mar. 17.	11 p.m. Mar. 7. 9 p.m. Mar. 11. (a).		
Adult.		7.30 p.m. Mar. 19.		7.45 p.m. Mar. 19.		7.45 p.m. Mar. 19.		
Length of Cycles.		29 days. 20 hours.		29 days. 20 hours.		29 days. 20 hours.		

Stadium No.	5. Females.		6. Males.		7. Males.		Ecdysis No.	
	Moults.	Meals.	Moults.	Meals.	Moults.	Meals.		
First.	4 p.m. Feb. 20.	(a). 7.30 p m. Feb. 14.	7 a.m. Feb. 20.	p.m. Feb. 11. 7.30 p.m. Feb. 14.	7 a.m. Feb. 20.	(a). 7.30 p.m. Feb. 14.	1.	
Second.	6 p.m. Feb. 25.	(a). (7 p.m. Feb 21.) (b).	5 p.m. Feb. 25.	7.30 p.m. Feb. 20. (b).	6 p.m. Feb. 25.	7 p.m. Feb. 20. (b).	2.	
Third.	6 a.m. Mar. 4.	(a). 1 p.m. Feb. 27. 6 p.m. Feb. 29.	noon, Mar. 1.	6.30 p.m. Feb. 26. (a).	8 a.m. Mar. 1.	6 p.m. Feb. 26. (a).	3.	
Fourth.	6 p.m. Mar. 13.	(a). 10 p.m. Mar. 7. (a).	8 a.m. Mar. 10.	8.30 p.m. Mar. 1 x 11.30 p.m. Mar. 4. (a). (=11.30 p.m. Mar. 7.)	4 p.m. Mar. 7.	8 p.m. Mar. 1. (a).	4.	
Fifth.	6 a.m. Mar. 22.	(8 p.m. Mar. 14.) 8 p.m. Mar. 16.	7 a.m. Mar. 19.	9.30 p.m. Mar. 11. (a).	2 p.m. Mar. 17.	11.30 p.m. Mar. 7. 10 p.m. Mar. 11. (a).	5. Adult.	
Adult.		7.40 p.m. Mar. 22.		7.40 p.m Mar. 22		7.30 p m. Mar. 19.		
Length of Cycles.		32 days. 21 hours.		32 days. 21 hours.		29 days. 20 hours.		

a. Refused. b. Refused throughout at 7 p.m. Feb. 24. c. Escaped at 6 p.m., Feb. 26. x. Partly fed; refused further. "( )" = Extra and irregular, unless followed by "(a)."

TABLE IV.

Duration of Postembryonic Stadia, the Food Supply Normal. Generation No. 3.

Stadium No.	1. Females.		2. Males.		3. Females.		Ecdysis.
	Moults.	Meals.	Moults.	Meals.	Moults.	Meals.	
First	8 a.m. Apl. 25.	9 p m. April 21	10 a.m. April 25	9 p.m. April 21	8 a.m. April 25	9 p.m. April 21	1
Second	8 a.m. May 2.	9.30 p.m. Apl. 26 (a)	4 p.m. May 1	9.30 p.m. April 26	9 a.m. May 2	9 45 p.m. April 26 (a)	2
Third	May 10 (d)	8.20 p.m. May 4	May 10 (d)	(a) 8 p.m. May 4	May 10 (d)	8.15 p.m. May 4	3
Fourth	9 a.m. June 7	9.15 p.m. June 2	10 a.m. June 8	9.30 p.m. June 2	7 p.m. June 9	10.05 p m. June 4	4
Fifth	4 p.m. June 28	11.10 p.m. Jun. 21	5 p.m. June 24	2.30 a.m. June 19	10.25 a.m. June 25	1.15 a.m. June 19	5
Adult		9.20 p.m. July 19		9.45 p.m. July 19		9 p.m. July 19	
Length of Cycles :	…	69 days, 14 hours		65 days, 15 hours		66 days, 8 hours	

Stadium No.	4. Females.		5. Females.		6. Females.		Ecdysis.
	Moults.	Meals.	Moults.	Meals.	Moults.	Meals.	
First	10 a.m. April 25	9 p m. April 21	2 p.m. April 25	9 p.m. April 21	Noon, April 25	9 p.m. April 21	1
Second	3 p.m. May 2	9.45 p.m April 26 (a)	5 p.m. May 1	10 p.m. April 26	10 a.m. May 2	10.15 p.m. Apr. 26 (a)	2

a. Refused. b. Escaped 11 p.m. Apr. 26. c. Died Apr. 30, 1908. d. Avg. time.

Stadium No.	4. Females.		5. Females.		6. Females.		Ecdysis.
	Moults.	Meals.	Moults.	Meals.	Moults.	Meals.	
Third	May 10 (d)	8 p.m. May 4	May 10 (d)	(a) 7.30 p.m. May 4	May 10 (d)	8.30 p.m. May 4	3
Fourth	11 a.m. June 9	9.45 p.m, June 4	5 p.m. June 6	8.45 p.m. June 2	7 a.m. June 9	9.05 p.m. June 2	4
Fifth	1 30 p.m. June 24	2 a.m. June 19	4 p.m. June 29	10.45 p.m. June 21	3 p m. June 24	1.45 a m. June 19	5
Adult		10 p.m. July 19		10.15 p.m. July 19		9.35 p.m. July 19	6
Length of Cycles:		65 days, 11 hours		70 days, 14 hours		65 days, 13 hours	

Stadium No.	7.		8.		9.		Ecdysis.
	Moults.	Meals.	Moults.	Meals.	Moults.	Meals.	
First	7.30 p.m. April 25	9 p.m. April 21		9 p m. April 21 (a) weak (c)	May 20 (d)	9 p.m. April 21 10.45 p.m Ap'il 26 9 p.m May 1 (a)	1
Second	(b)	10.30 p.m. April 26			Noon, June 11	9 20 p m. June 2	2
Third					7 p.m. June 27	11.25 p m. June 21	3
Fourth					4 p.m. July 20	11.10 p.m. July 14	4
Fifth						Died, Aug 30	5

This second generation was descended from pair No. 1, first generation (Nos. 2 and 3). The eight eggs were deposited at 6 a.m., Feb. 1, 1908, and hatched at 4 p.m., Feb. 10, 1908, average time (from 8 p.m., Feb. 7, to a.m., Feb. 16). The total average temperature for each individual was as follows: No. 1, *3023.2°* Fahr.; No. 2, *3023.2°* Fahr.; No. 3, *2929.9°* Fahr.; No. 5, *3356.7°* Fahr.; No. 6, *3107.8°* Fahr.; No. 7, *3023.2°* Fahr. If these temperatures are averaged, very little variation will be shown.

TABLE IVa.

Length of Larval Life or Stages, Irregularly Feeding (Previous History Unknown, but from Human Beds).

No.	Stage.	Captured.	Condition.	Meals.	Moulted.	Died.	Length of Life, Days.	Remarks.
1	Fifth	Sep. 11, 1905	gorged	none	Sep. 20	Adult	9+	See No. 2, table V a.
2	Fifth	Sep. 11, 1905	gorged	none	Sep. 18	Adult	7+	See No. 3, table V a.
3	Fifth	Sep. 11, 1905	gorged	none	Sep. 14	Adult	3+	See No. 4, table V a.
4	Fourth	Sep. 4, 1905	pale	Sep. 20 Nov. 15 Mar. 31	Sep. 28, 1905 Apl. 13, 1906	Adult	221+	See No. 7, table V a.
5	First	Sep. 19, 1905	full-fed	Nov. 15	Sep. 23	Mar. 31, 1906	194+	Human blood. Laundry, Washington, D.C.
6	Fifth	Sep. 11, 1905	full-fed	none	Sep. 19	Adult	8+	Washington, D.C. See No. 8, table V a.
7	Fifth	Sep. 11, 1905	full-fed	none	Sep. 19	Adult	8+	Washington, D.C. Lodging House, 9, table V a.
8	First	Oct. 17, 1905	hatched	Nov. 15		Nov. 3	17	Washington, D.C. From No. 9 of table V a.
9	First	Oct. 17, 1905	hatched	Nov. 16		Nov. 1	15	Washington, D.C. From No. 9 of table V a.
10	Fifth	Sep. 11, 1905	full-fed	none	Sep. 19	Adult	8+	Washington, D.C. See No. 10, table V a.
11	First	Aug. 7, 1907.	pale	none		Sep. 4	28+	Cincinnati, Ohio, steamboat.
12	First	Aug. 7, 1907.	pale	none		Sep. 11	35+	Cincinnati, Ohio, steamboat.

This generation was directly descended from the second generation above (Pair No. 3, Nos. 5 and 6). The eggs hatched at the average time of 2 a.m., April 20, 1908. The total average temperature for each individual is not available.

For other connected facts see part I, Journ. Econ. Biology, ib., Tables I and II.

In Table IV a is summed up the length of life of captured larvae whose previous history is unknown but which were allowed food irregularly.

TABLE V.

Duration of the Adult Stadium, Normally Feeding and Mating.

Individual No.	Sex.	Adult. Date.	First Meal.	Subsequent Meals. (Engorgement)	Mated.	Died.	Length of Life.		Remarks.
							Days.	Hours.	
1	Female	Noon, Oct. 30, 1907	10 p.m. Nov. 1, 1907	20 (July 20) (b)	8.30 p.m. Feb. 23, 1908 (c)	Aug. 10, 1908	316	12	No. 1, Gen. No. 1.*
2	Female	5 p.m. Nov. 19, 1907	11.45 a.m. Nov. 24, 1907	9 (Jan. 27)	9.30 p.m. Dec. 22, 1907	Feb. 15, 1908	88	7	No. 2, Gen. No. 1.
3	Male	4 p.m. Nov. 9, 1907	11 a.m. Nov. 24, 1907	14 (Apr. 29)	9.30 p.m. Dec. 22, 1907 (a)	May 18, 1908	191	8	No. 3, Gen. No. 1.
4	Female	6 p.m. Oct. 23, 1907	8 p.m. Oct. 23, 1907	17 (May 16)	8.30 p.m. Feb. 23, 1908	May 19, 1908	209	6	No. 4, Gen. No. 1.
5	Female	9 a.m. Mar. 18, 1908	7.30 p.m. Mar. 19, 1908	5 (Apr. 26)	7 p.m. Mar. 18, 1908	May 11, 1908	54	15	No. 1, Gen. No. 2.
6	Male	9 a.m. Mar. 18, 1908	7.45 p.m. Mar. 19, 1908	8 (July 4)	9.30 p.m. Apr. 30, 1908	Sep. 20, 1908	186	15	No. 2, Gen. No. 2.†
7	Male	6 a.m. Mar. 17, 1908	7.45 p.m. Mar. 19, 1908	8 (July 4)	Not at all.	Sep. 20, 1908	187	18	No. 3, Gen. No. 2.
8	Female	6 a.m. Mar. 22, 1908	7.40 p.m. Mar. 22, 1908	5 (Apr. 26)	7.40 p.m. Mar. 22, 1908	May 15, 1908	54	18	No. 5, Gen. No. 2.
9	Male	7 a.m. Mar. 19, 1908	7.40 p.m. Mar. 19, 1908	8 (July 4)	7.40 p.m. Mar. 22, 1908	Sep. 24, 1908	189	17	No. 6, Gen. No. 2.
10	Male	2 p.m. Mar. 17, 1908	7.30 p.m. Mar. 19, 1908	8 (July 4)	7 p.m. Mar. 18, 1908	Nov. 4, 1908	232	10	No. 7, Gen. No. 2.
11	Female	4 p.m. June 29, 1908	10.15 p.m. July 19, 1908	1 (July 31)	Not at all.	Sep. 18, 1908	81	0	No. 5, Gen. No. 3.
12	Female	10.30 a.m. June 25, 1908	9 p.m. July 19, 1908	1 (July 31)	Not at all.	Sep. 18, 1908	85	12	No. 3, Gen. No. 3.
13	Female	4 p.m. June 28, 1908	9.30 p.m. July 19, 1908	2 (Aug. 10)	10 p.m. July 19, 1908	Sep. 1, 1908	65	8	No. 1, Gen. No. 3.*
14	Male	5 p.m. June 24, 1908	9.40 p.m. July 19, 1908	2 (Aug. 10)	11 p.m. July 19, 1908	Oct. 2, 1908	100	7	No. 2, Gen. No. 3.
15	Female	1 p.m. June 24, 1908	10 p.m. July 19, 1908	2 (Oct. 9, 1908)	Not at all.	Jan. 15, 1909	205	11	No. 4, Gen. No. 3.
16	Female	3 p.m. June 24, 1908	9.30 p.m. July 19, 1908	2 (Oct. 9, 1908)	Not at all.	Jan. 15, 1909	205	9	No. 6, Gen. No. 3.

* Fertile Eggs. † Mated with No. 4 above.

a. Also at 8.15 p.m., February 18, 1908, with No. 9, Generation No. 1.
b. The dates in parentheses are last meals.
c. Also at 1 a.m., July 4, 1908, with No. 10 of its generation. See table VI.

Of these sixteen adults, which may represent very well the same number matured at random in their variable environments (especially as regards food), five eighths lived longer than three months and nearly the same portion longer than half a year. The sexes are about equally represented in this respect.

TABLE V a.

Length of Adult Life, Irregularly Feeding (Previous History Unknown, but from Human Beds).

Individual No.	Sex.	Captured.	Condition.	Meals.	Mated at all.	Died.	Length of Life. Days.	Remarks.
1	♀	Sep. 11, 1905	Flat, coloured	Sep. 20, 1905	?	Sep. 22	11+	Fed on a mouse (*Mus* sp.). Washington, D.C.
2		Sep. 20, 1905	Hungry, moulting	Sep. 20, scanty	?	Nov. 10	51	Fed on a mouse, but very scantily. No. 1 of table IV a.
3		Sep. 18, 1905	Hungry, moulting	Sep. 20, scanty	?	Nov. 2	45	Fed on a mouse, but very scantily. No. 2 of table IV a.
4		Sep. 14, 1905	The samo	The same	?	Oct. 15	21	Fed on a mouse, but very scantily. No. 3 of table IV a.
5	♂	Mar. 18, 1910	Flat, coloured	Mar. 20, 30	?	April 20	33+	Fed on human blood. Normal, Illinois.
6	♂	Mar. 26, 1910	Partly fed	Mar. 20	?	April 20	25+	Fed on human blood. Chicago.
7	♀	Apr. 13, 1906	Hungry, moulting	May 9, 21; June 2	No	Aug. 23	132	Fed on mole and human blood. No. 4 of table IV a.
8		Sep. 19, 1905	The same	Sep. 28; Nov. 23; Apr. 4	No	Apr. 15, 1906	209	Fed on mouse, human and bird blood; a few eggs. No. 6 of table IV a.
9	♀	Sep. 19, 1905	The same	Sep. 28; Nov. 15	Yes	Apr. 21, 1906	215	Fed on mouse and human blood; a few eggs. No. 7 of table IV a.
10		Sep. 19, 1905	The same	Sep. 28; Nov. 30; Mar. 31	?	May 1, 1906	225	Fed on mouse and human blood. No. 10 of table IV a.
11	♀	Sep, 15, 1905	Full-fed	Sep. 27	Yes	Oct. 3	18+	Chicago. Fed on guinea pig. Fifteen eggs.
12	♂, ♀	Sep. 20, 1905	Hungry, moulting*	Sep. 26†				

*Nymph V on September 18; moulted two days later. Full fed when captured on September 18. †Several others at irregular intervals, but the records have been lost.

TABLE VI.

Summary of the Duration of the Adult Stadium, the Larval Food Abnormal.

Individual No.	Sex.	Date of Maturity 1908.	First Meal.	Subsequent Meals. Engorgement.	Mated.	Death.	Duration of Life.		Remarks.
							Days.	Hours.	
1	Male	9 p.m. Jan. 9	Noon, Jan. 12, 1908	7½ (April 12) (b)	9 p.m. Feb. 23, 1908	April, 18, 1908	100	3	No. 6, Generation 1
2	Female	6 p.m. Jan. 17	6 p.m. Jan. 29, 1908	10 (April 29)	9 p.m. Feb. 18, 1908	May 11, 1908	115	0	No. 8, Generation 1
3	Female	11 p.m. Jan. 16	6 p.m. Jan. 29	11 (April 29)	8 p.m. Feb. 18, 1908	May 10, 1908	115	1	No. 9, Generation 1
4	Male	7 p.m. Jan. 9	Noon, Jan. 12	14 (July 4)	9 p.m. Feb. 18 (a)	Aug. 8, 1908	212	5	No. 10, Generation 1

a. Also at 1 a.m., July 4th, 1903, with No. 1 of its generation. See table V.

b. Date of last meal.

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TABLE VII.

Duration of Life Without Food, First Stadium. Starvation from Birth.

Lot No.	No Individuals.	Hatched (Average time)	Died (Average time).	Mean Duration of Life.		Place.		Remarks.
				Days.	Hours.			
1	2	8 a.m. October 1, 1910	October 30, 1910	29	0	Urbana	Illinois	One lived until April 7, following.
2	6	6 a.m. March 8, 1908	March 30, 1908	22	0	,,	,,	This lot at much lower temperature than usual.
3	6	6 a.m. March 13, 1908	April 24, 1908	42	0	,,	,,	
4	3	8 p.m. Feb. 11, 1908	March 1, 1908	19	0	,,	,,	The first died on the 6, the last on the 26.
5	10	4 a.m. Jan. 16, 1908	Feb. 16, 1908	31	6	,,	,,	
6	1	5 a.m. Jan. 28, 1908	Feb. 29, 1908	32	0	,,	,,	
7	2	January 24, 1908	Feb. 25, 1908	32	0	,,	,,	
8	1	7 a.m. Feb. 4, 1908	March 12, 1908	37	0	,,	,,	
9	1	7 a.m. March 3, 1908	March 25, 1908	22	0	,,	,,	
10	6	March 5, 1908	March 26, 1908	21	0	,,	,,	
11	2	6 a.m. March 6, 1908	March 27, 1908	21	0	,,	,,	
12	2	6 a.m. March 7, 1908	April 4, 1908	28	0	,,	,,	
13	1	7 a.m. March 1, 1908	April 6, 1908	36	0	,,	,,	
14	1	7 a.m. March 9, 1908	April 7, 1908	29	0	,,	,,	
15	6	10 a.m. March 15, 1908	April 10, 1908	26	0	,,	,,	
16	3	9 a.m. March 24, 1908	April 17, 1908	24	0	,,	,,	
17	3	11 a.m. March 7, 1908	April 17, 1908	41	0	,,	,,	
18	4	3 p.m. March 16, 1908	April 16, 1908	31	0	,,	,,	
19	5	7 a.m. March 28, 1908	April 25, 1908	28	0	,,	,,	
20	2	8 p.m. April 7, 1908	April 24, 1908	17	0	,,	,,	
21	4	4 p.m. April 7, 1908	April 29, 1908	22	0	,,	,,	
21	71			590	6			
Average	3.3			28.1				

Table VIII.

Duration of Larval Life Without Food from Time of Capture. (Previous History Involving some Food.)

Individual No.	Origin.	Approximate Age Stadium.	Condition When Captured. Date.	Died.	Duration of Life. Days.	Remarks.
1	Lodging House (D.C.)	Fifth	Full-fed. Sept. 11, 1905.	Nov. 2, 1905.	52	Moulted to adult; given very small
2	Idem.	Fifth	Full-fed. Sept. 11, 1905.	Oct. 15, 1905.	34	amount of mouse blood.
3	Idem.	Fifth	Full-fed. Sept. 11, 1905.	Nov. 10, 1905.	60	Moulted to adult. Not fed at all.
4	Idem (Chicago).	Second	Partly-fed, pale. Feb. 2, 1909.	Feb. 21, 1909.	19	Mean; 7 nymphs I-III. Two moulted.
5	Idem (Chicago).	Third	Partly-fed, pale. Nov. 15, 1910.	Dec. 5, 1910.	20	
6	Idem (Id).	Fifth	Pallid. Feb. 2, 1909.	Mar. 10, 1909.	36	
7	Hotel, Centralia, Ill.	Third	Pallid, flat. June 27, 1910.	July 14, 1910.	17	
8	Idem.	Second	Full-fed. June 27, 1910.	July 25, 1910.	28	
9	Idem.	Third	Pale, flat. June 27, 1910.	July 17, 1910.	20	
10	Idem.	Fourth	Pale, flat. June 27, 1910.	July 21, 1910.	24	
Average,					31	

TABLE IX.

Duration of Adult Life without Food from time of capture (Previous History Involving some Food).

Individual No.	Origin.	Condition when Captured. Date.	Died.	Duration of Life. Days.	Remarks.
1	Hotel, Centralia, Ill.	Recently fed. June 27, 1910	July 27, 1910	30	
2	Idem.	Dark, flat. June 27, 1910	July 27, 1910	23	Male.
3	Lodging House, Chicago	Full-fed. Feb. 2, 1909	Feb. 11, 1909	9	Male; noticeably weaker three days before death.
4	Idem.	Partly-fed. Nov. 15, 1910	Dec. 26, 1910	41	Female.
5	Idem.	Idem.	Jan. 1, 1911	47	Male.
6	Idem.	Idem.	Dec. 29, 1910	44	Female.
7	Idem.	Idem.	Jan. 2, 1911	48	Female.
8	Idem.	Idem.	Dec. 16, 1910	31	Male.
9	Idem.	Idem.	Nov. 28, 1910	13	Male.
10	Idem.	Idem.	Dec. 20, 1910	35	Female.
11	Idem.	Idem.	Dec. 16, 1910	31	Female.
12	Boarding House, Washington, D.C. (a)	Full-fed. March 28, 1905	May 27, 1905	60	
13	Residence, Urbana, Ill.	Partly-fed. July 23, 1908	Aug. 15, 1908	26	Female.
14	Hotel, Aurora, Ill.	Same. Oct. 2, 1908	Oct. 8, 1908	6	Male.
15	Lodging House, Chicago	Same. Sep. 15, 1910	Sep. 26, 1910	11	Female. Deposited a few fertile eggs.
16	Idem.	Full-fed. Feb. 2, 1909	Feb. 20, 1909	18	Female. Few eggs. Confined with No. 17.
17	Idem.	Idem.	Idem	18	Male.
18	Hotel, Peoria, Ill.	Flat, colored. Mar. 6, 1911	March 8, 1911	2	Male.
19	Boarding House, Chicago (a)	Partly-fed. July 15, 1911	July 30, 1911	15	Female. A few eggs.
20	Idem.	Idem.	July 27, 1911	12	Male.
21	Idem.	Idem.	July 29, 1911	14	Male.
22	Idem.	Idem.	Aug. 5, 1911	21	Female. A few eggs.
23	Stateroom, Steamboat, Cincinnati	Partly-fed. Aug. 7, 1907	Aug. 26, 1907	19	Female. Deposited 10 eggs.

a. Fully coloured at death.

No records have thus far been made for adults starved from maturity.

A FURTHER CONTRIBUTION TOWARDS A KNOWLEDGE OF THE BRITISH THYSANOPTERA (*TEREBRANTIA*).

By

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With 5 Figures.

Since my last paper in this Journal was published I have had but little opportunity of collecting, my chief captures being made at the various field meetings of the Northumberland and Durham Natural History Society, during my year of presidency, 1911, and on two outings on the occasion of the British Association Meeting at Portsmouth, last year, when I spent some hours collecting in the New Forest, and at Blackgang Chine, Isle of Wight, with Mr. C. B. Williams. A few interesting Oxford captures are included in the following records, whilst the discovery of the new species, *Physothrips latus*, was made by my friend, Mr. H. S. Wallace.

It will be well to briefly point out certain necessary alterations in my preliminary list of the British Species (Journ. Econ. Biol., 1911, vi, p. 11).

1. The Genus *Euthrips*, Targ.-Tozz., should be known as *Physothrips*, Karny.
2. *Euthrips primulae*, Hal., should read *Taeniothrips primulae*, forming the type of that genus.
3. The Genus *Anaphothrips*, Uz., should be known as *Euthrips*, Targ.-Tozz.

In the Tubulifera :

4. The Genus *Anthothrips*, Uzel, becomes *Haplothrips*, Serville.
5. The Genus *Acanthothrips*, Uzel, becomes *Hoplothrips*, Serville, and the species *A. nodicornis*, Reut., must be known as *Hoplothrips corticis*, Serville. *Acanthothrips doanei*, Moulton, is also a synonym of *H. corticis*.

[Journ. Econ. Biol., December, 1912, vol. vii, No. 4.]

6. *Liothrips hradecensis*, m., has been compared with Uzel's type by Prof. Karny, who shows that the species are not identical, and that mine falls into his genus *Hoodia*. It must now be known as *Hoodia bagnalli*, Karny.
7. The species *Cephalothrips monilicornis*, Reut., is recorded by me from the New Forest, and must be added.

Certain questions relating to synonymy should also be made clear.

8. *Frankliniella vulgatissima*, Uzel nec Hal., becomes a synonym of *F. intonsa*, Trybom, and
9. *Physothrips pallipennis*, Uzel., must now be known as *P. vulgatissimus*, Hal.
10. *Physothrips longipennis*, Bagnall, has been redescribed by Moulton from North America under the name of *parvus*, which name must be sunk as a synonym.
11. The discovery of the male of *Bagnallia agnessae*, Bagn., shows it to be identical with *B. halidayi*, Bagn., described from male specimens only. The name *B. halidayi* is therefore reduced to a synonym.

In the following notes *Rhipidothrips gratiosus*, Uzel, *Chirothrips hamatus*, Trybom, *Frankliniella tenuicornis*, Uzel, *Physothrips latus*, sp. nov., *Bagnallia dilatata*, Uzel, *B. klapalcki*, Uzel, and *Stenothrips graminis*, Uzel, are brought forward as British.

Rhipidothrips gratiosus, Uzel.

Uzel, Monographie der Ordnung Thysanoptera, 1895, p. 66, pl. v, figs. 42, 43.

This fine, and moderately large species is easily recognised on the field on account of its unusual coloration, the ivory white prothorax and wings, and its black head, longer than broad, making it a conspicuous capture.

I have taken female specimens on two occasions by beating cereals in fields near Oxford, July 14th and 15th, 1912.

Previously known from Bohemia (Uzel).

Reuter has described a second species, *Rhipidothrips niveipennis*, from *Abies* and *Convallaria*, Finland.

Aeolothrips vittatus, Hal.

On pine, sparingly, females only. Prestwick Carr; Riding Mill, and near Hexham, Northumberland. I have also taken examples from pine in Southern Norway.

Melanothrips fuscus (Sulz.).

In various flowers, rare; both sexes. Gibside, Co. Durham; Wylam, Northumberland, and Oxford.

Chirothrips hamatus, Trybom.

C. hamata, Trybom, Ent. Tidskrift, 1895, xvi, p 187.
C. dudae, Uzel, Monographie der Ordnung Thysanoptera, 1895, p. 83, pl. i, fig. 7, and pl. v, fig. 50.

One female on rushes growing by side of Harbottle Lough, Harbottle, June, 1911, and another on grass (with *Cephalothrips monilicornis*, Reut., also an addition to the British fauna) at Matley Bog, New Forest, August, 1911. I characterised the species of *Chirothrips* in tabular form in this Journal (1909, vol. iv, p. 34).

Oxythrips ajugae, Uzel, 1895.

One female by beating pine branches, together with *O. brevistylis*, Harbottle, Northumberland, June, 1911.

Oxythrips brevistylis (Trybom).

A few by beating the male flowers of pine, Harbottle, June, 1911.

Oxythrips parviceps (Uzel).

In heaths, Harbottle district, June, 1911; New Forest, near Matley Bog, and Blackgang Chine, Isle of Wight, August, 1911.

Frankliniella tenuicornis (Uzel).

Physopus tenuicornis, Uzel, Monographie der Ordnung Thysanoptera, 1895, p. 99.

A single female taken on a soft grass by the side of Selby's Lough, near Harbottle, Northumberland, June, 1911.

Readily separated from *intonsa* (Trybom) by having the fifth joint of the antenna (which is somewhat strikingly slender) dark.

Physothrips latus, n.sp.

Length 0.9 mm., breadth of mesothorax 0.26 mm.

Female: general colour pale grayish-yellow; pigmentation of ocelli orange-red and of eyes purplish-black to crimson. First and third antennal joint clear grayish-yellow, second, fourth (base lighter), fifth, sixth and style grayish-brown. Wings grayish, pterothorax shaded to grayish-brown at sides, last two abdominal segments shaded to gray-brown, darkest at sides.

Form broad. Head with cheeks arched; inter- and postocular bristles present; together with a somewhat slender pair immediately behind the ocelli. Mouthcone shaded to dark grayish-brown at tip; reaching across prosternum; maxillary palpi 3-jointed, first joint slightly longer than the third, middle joint shortest.

Prothorax with a pair of fairly long bristles at each posterior angle, postero-marginal, mid-lateral and antero-marginal pairs present but smaller. Wings long; fore-wing with eighteen bristles on fore-margin, nine along the hind-vein, a series of six near base and two on apical third of fore-vein. Legs unusually long. Abdomen ovate, short and broad, but slightly longer than the length of the prothorax and pterothorax together, and three-quarters as broad as long. Last segment short and broad. Apical spines dark, long and strong on last two segments, moderately long on segment seven and weaker and shorter on sixth, other dorsal bristles minute and inconspicuous, lateral bristles well-developed.

Type.—In coll. Bagnall, University Museum, Oxford.

One female taken by Mr. H. S. Wallace in a garden on *Scabiosa* at Ninebanks, nr. Whitfield, Northumberland, in the summer of 1911. The Rev. J. E. Hull, of Ninebanks, sent me a tube of thrips containing other examples of *latus,* but at the moment it is mislaid amongst my numerous boxes of material.

Comes in the *orchidi,* Moulton, and *longipennis,* Bagn., group, and is easily distinguished from other species by its broad form and distinctive type of colouration. The antennae in the type specimen are set in such a fashion as to make it impossible to approximate the relative lengths of the joints.

Amblythrips ericae, Bagnall, 1911.

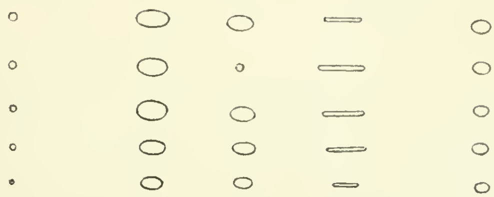
This larval-like little thrips is evidently not uncommon and widely spread in Great Britain, chiefly affecting the Cross-leaved Heath, *Erica tetralix.* In August, 1911, Mr. C. B. Williams and I took both sexes in fair numbers near Matley Bog in the New Forest, and in plenty in Blackgang Chine, Isle of Wight. In the spring of 1911 I met with a few examples in Gibside, Co. Durham, and in Tynedale at Riding Mill, whilst hard work produced a number on the moors near Harbottle, a village in the hills south of Cheviot, and ten miles from the nearest station, Rothbury.

Excepting in the structure of the genitalia, the male does not differ greatly from the female.

Bagnallia agnessae, Bagnall, 1911.

Syn: Male, **B. halidayi,** Bagnall, 1911.

This species occurs in large numbers in its original habitat, Gibside, and in April, 1911, I discovered it on the same species of grass growing near the margin of a pond in a Wear Valley dene near Fence-houses, Co. Durham.



1 2 3 4 5

Outline of areas on the underside of abdominal segments three to seven.

1. *Limothrips cerealium* (Hal.). Ma'e.
2. *Bagnallia dilatata* (Uzel). Male.
3. *Bagnallia angusticeps* (Uzel). Male.
4. *Bagnallia agnessae,* Bagnall. Male.
5. *Stenothrips graminum,* Uzel. Male.

I have taken the male from both these localities in plenty; it is very unlike the female, and turns out to be the same form as the males described by me from Epping Forest under the name of *Bagnallia halidayi.* This latter name must sink as a synonym of *agnessae.*

All the females have short wings, whilst the males are brachypterous, the wings being reduced to white pads.

Bagnallia dilatata (Uzel).

Thrips dilatatus, Uzel, Monographie der Ordnung Thysanoptera, 1895.

A single mutilated specimen, male, taken in a flower of the March Red Rattle, *Pedicularia palustris,* Holystone, near Harbottle, Northumberland, June, 1911, is, I think, referable to this species.

Bagnallia klapaleki (Uzel).

Thrips klapaleki, Uzel, Monographie der Ordnung Thysanoptera, 1895.

A single dead and mutilated female beaten from rushes (with *Chirothrips hamatus,* Trybom) by the side of Harbottle Lough, agrees well with Uzel's description of *klapaleki.* The male is unknown. Previously recorded from Bohemia (Uzel) and Italy (Buffa).

Aptinothrips nitidulus, Hal.

On maritime plants: Ettrick Bay, on the Island of Bute, 1911, and at Lochgoilhead, May, 1912.

Stenothrips graminum, Uzel.

Uzel, Monographie der Ordnung Thysanoptera, 1895, p. 210, pl. ii, fig. 16.

Both sexes occur commonly on cereals in the neighbourhood of Oxford, July, 1912, and at Tring, August, 1912.

I had previously searched for *Stenothrips* in the North of England without success, and since finding it at Oxford I made a further search in the County of Durham, but only found *Limothrips cerealium* and *Haplothrips aculeatus*. *Stenothrips* is undoubtedly an injurious form apparently replacing *Limothrips* in some districts; it occurs in countless numbers

It has been recorded from Bohemia (Uzel), Poland (Schille), Germany (Coesfeld), Italy (Ribaga), and Denmark (R.S.B.).

REVIEWS.

Balls, W. L.—The Cotton Plant in Egypt. Pp. xvi + 202, 72 figs. London: Macmillan and Co., Ltd. 1912. Price 5s. net.

This work forms the first biological volume in the excellent series of Science Monographs now in course of publication by Messrs. Macmillans.

The work is divided into four sections, treating respectively of the cotton plant under the following headings:—(1) Historical. (2) The Individual Plant. (3) The Race; and (4) Economics.

The fertilisation, cytology, embryology, development and environment are very fully described. Chapters are devoted to commercial varieties, natural crossing, heredity and economics, the last mentioned being perhaps the least satisfactory. The two chapters on heredity are particularly interesting.

As the author states, he has written with divided attention, for there is so much of genuine interest in his subject to botanist, economist, cotton spinner and irrigation engineer, it was scarcely possible to do otherwise; nevertheless, he has given us a most interesting volume, full of important results.

Broun, A. F.—Sylviculture in the Tropics. Pp. xvi + 309 and 96 figs. London: Macmillan and Co., Ltd. 1912. Price 8s. 6d. net.

The author's practical experience in India and the Sudan eminently fit him to write a book of this character.

It is not possible, in the space at our disposal, to do more than very briefly indicate the scope of the work. It is divided into four parts, viz., (1) Factors governing and influencing the existence of forests. (2) Formation and regeneration of woodland crops. (3) Training and improving of forests; and (4) Special measures of maintenance and protection. Under these four headings we have a thorough guide to tropical forestry, carefully written and well illustrated, which will be welcomed by many who desire a complete yet handy volume on the subject.

Castle, W. E. and others.—Heredity and Eugenics. Pp. vii + 315 and 98 figs. London: The Cambridge University Press. 1912. Price 10s. net.

During the summer of 1911 a course of lectures on heredity and allied topics was given at the University of Chicago, intended for those interested in the progress of genetics as a matter of information rather than of study, and they excellently serve this purpose.

Professor Coulter contributes two chapters, the first, on recent developments in heredity and evolution, serving as a general introduction; the second deals with the physical basis of heredity and evolution from the cytological standpoint. The method of evolution, and heredity and sex, form the subjects of Professor Castle's lectures; and inheritance in the higher plants, and the application of biological principles to plant breeding, Professor East's. Professor Tower deals with recent advances and the present state of knowledge concerning the modification of the germinal constitution of organisms by experimental processes; and Professor Davenport with the inheritance of physical and mental traits of man and their application to eugenics, and the geography of man in relation to eugenics.

It would be invidious to single out any of the different lectures for special mention. Together they form an interesting and admirable summary of recent advances in our knowledge of variation, heredity, and evolution in relation to plant and animal life, and human improvement and welfare.

It was a wise decision to publish these lectures, and we are glad to learn that it is proposed to follow this volume by others representing the most significant aspects of current biological investigation.

Hewitt, C. G.—House-Flies, and how they spread Disease. Pp. xii + 122 and 20 figs. Cambridge: The University Press, 1912. Price 1s. net.

Dr. Howard's recent work has so ably covered the ground on the subject of house-flies and disease, that little more remains to be said; nevertheless, Mr. Hewitt has given us in small compass an intensely interesting little volume, that will appeal to a wide circle of readers.

The work is divided into two parts, treating of the natural history of the house-fly and the relation of house-flies to disease respectively. There are numerous excellent illustrations which greatly add to the value of the work.

Hooper, Cecil H.—Fruit Farming: Practical and Scientific. Pp. iv + 130. Illustrated. London: The Lockwood Press. 1912. Price 3s. 6d. net.

We are frequently asked to recommend a really practical handbook on fruit farming, but hitherto such has not been available. There are plenty of manuals, more or less theoretical, on particular fruits, but one of the nature of Mr. Hooper's has long been desired. At the outset let us say this book will grow, and later editions will amplify and amend much in the present one; nevertheless, it covers in an admirable manner

all sides and phases of the subject. We strongly recommend it to all interested in fruit growing, whether for pleasure or profit, and heartily congratulate the author and his co-helpers on its production.

Lydekker, R.—The Sheep and its Cousins. Pp. xv + 315, 24 plts. and 11 figs. London: George Allen and Co., Ltd. 1912. Price 10s. 6d. net.

It seems curious, seeing that the sheep is one of the most valuable and important of all domesticated animals, that there is no modern work in English that deals with the chief breeds. This gap has now been filled by Mr. Lydekker's volume.

After a short account of the early history and names of the sheep, a chapter is devoted to its zoological position and structure, followed by very interesting accounts of the different breeds. The diffusion of domesticated sheep is briefly reviewed, and in spite of our inadequate knowledge of the Asian breeds, a wealth of information has been brought together on this subject. The volume closes with short accounts of aberrant wild sheep and some extinct sheep.

The work is beautifully illustrated by twenty-four excellent plates, and cannot fail to interest the zoologist generally, as well as prove both useful and interesting to breeders and flock-masters.

Minchin, E. A.—An Introduction to the Study of the Protozoa. Pp. xi + 517, 194 figs. London: Edward Arnold. 1912. Price 21s. net.

Students of protozoology cannot fail but feel greatly indebted to Professor Minchin for this very comprehensive and well-arranged work. The science of protozoology covers so vast a field, and almost daily is receiving new additions to knowledge, that the author's task has been no light one; nevertheless, he has presented us with an excellent introduction which summarises our knowledge to-date of this important science.

In his preface he states that his aim has been to furnish a guide to those biologists who desire a more intimate acquaintance with the special problems presented by the Protozoa, attempting to define the position of these organisms in Nature, and to determine more exactly what should and what should not be included under the term "Protozoa." Further, care has been taken to define or explain fully all technical terms, in a subject abounding in technicalities and an extensive vocabulary. Finally, he introduces the student to the vast series of forms and their systematic classification, so far as these can be inferred from their structural peculiarities and their life-histories.

In addition, attention is drawn to various problems which the Pro-

tozoa shed light on, and there is a special chapter dealing with the physiology of the Protozoa. There is also a very full bibliography and index.

The work has been well conceived and ably carried out, and must prove a boon to all students of the subject.

Sladen, F. W. L.—The Humble-Bee, its Life-History and how to Domesticate it, with Descriptions of all the British Species of *Bombus* and *Psithyrus*. Pp. xiii + 283, 6 plts. and 34 figs. London: Macmillan and Co., Ltd. 1912. Price 10s. net.

The author's long acquaintance with Humble-Bees makes the present work not only an interesting one from the standpoint of the naturalist, but one of considerable value to the entomologist, and this value is increased by the excellent coloured plates.

Mr. Sladen has a first-hand knowledge of the life-histories of these insects, from long continued observations made on colonies kept in artificial domiciles, and he sets forth very clearly full particulars of the methods employed.

The life-histories of *Bombus* and *Psithyrus* are described at length, and their parasites and enemies. A large amount of space is devoted to the systematic descriptions of the twenty-three British species, and there are numerous other matters of interest.

Swanton, E. W.—British Plant Galls. Pp. xv + 287, 32 plts. and 33 figs. London: Methuen and Co., Ltd. 1912. Price 7s. 6d. net.

Mr. Swanton's original intention to publish a descriptive catalogue of the galls arising in plant tissues due to parasitic insects and fungi, was happily modified, and as a result we have the present handy and useful volume before us.

The author has given cecidologists a wealth of information, much of which has not previously been available in any English text-book, and the numerous coloured and other illustrations make it the most complete account we have upon the subject.

We must confess that we should have welcomed some information on the morphology and biology, and have liked to have seen the Catalogue under some different system of arrangement. Should a further edition be called for, this latter point and the nomenclature would well repay careful revision. There is a very full bibliography, though by no means complete. Much that has been published in this country previously on the subject of Plant Galls has been rather of the nature of picture books; we therefore congratulate Mr. Swanton on an attempt to deal with the subject in a serious yet interesting manner.

CURRENT LITERATURE.

I.—General Subject.

Bulletin of the Bureau of Agricultural Intelligence and Plant Diseases. No. 8. Rome: International Institute of Agriculture, 1912.

Bulletin of the Bureau of Economic and Social Intelligence. No. 7. Rome: International Institute of Agriculture, 1912.

Pearl, R.—The Mode of Inheritance of Fecundity in the Domestic Fowl. Journ. Exp. Zool., 1912, vol. 13, pp. 153-268.

Raitt, W.—Report on the Investigation of Bamboo as Material for Production of Paper-pulp. Ind. For. Rec., 1912, vol. 3, pp. 1-37.

Wellington, R.—Influence of Crossing in increasing the Yield of the Tomato. N.Y. Agric. Exp. Stat., Bull. No. 346, 1912, pp. 57-76.

II.—Anatomy, Physiology, and Development.

Prell, H.—Beitrage zur Kenntnis der Proturen. Zool. Anz., 1912, Bd. 40, pp. 33-50.

Shaw, F. J. F.—The Morphology and Parasitism of *Rhizoctonia*. Mem. Dept. Agric. India, Bot. Ser., 1912, vol. 4, pp. 115-153, plts. i-xi and 5 figs.

Verhoeff, K. W.—Über Felsenspringer Machiloidea. VI. Aufsatz: *Halomachilis* und *Forbiciana*. Zeit. wiss. Insektenbiol., 1912, Bd. 8, pp. 227-231, 6 fign.

III.—General and Systematic Biology, and Geographical Distribution.

Amundsen, E. O.—Wistaria Gall Fly. *Agromyza schineri* (Giraud). Mon. Bull. State Comms. Hort. Sacr., Cal., 1912, vol. 1, pp. 730-733, 4 figs.

Bagnall, R. S.—On a new Genus of Indian Thrips injurious to Turmeric. Rec. Ind. Mus., 1912, vol. 7, pp. 257-260, plt. 7.

Baker, C. F., and E. O. Essig.—Host Index to California *Coccidae*. Mon. Bull. State Comms. Hort. Sacr., Cal., 1912, vol. 1, pp. 740-763.

Carnes, E. K.—Some Experiments with the Common Ladybird (*Hippodamia convergens*). Mon. Bull. State Comms. Hort. Sacr., Cal., 1912, vol. 1, pp. 821-828.

Chapman, T. A.—On the Early Stages of *Albulina pheretes*, a Myrmecophilous Plebeiid blue butterfly. Trans. Entom. Soc. Lond., 1912, pp. 393-406, plts. xviii-xxxvi.

Compere, G.—A Few Facts concerning the Fruit Flies of the World. Mon. Bull. State Comms. Hort. Sacr., Cal., 1912, vol. 1, pp. 709-730, 12 figs.

Crawford, J. C.—Descriptions of New Hymenoptera. No. 5. Proc. U.S. Nat. Mus., 1912, vol. 43, pp. 163-188.

Davidson, W. M.—Aphid Notes from California. Journ. Econ. Entom., 1912, vol. 5, pp. 404-411, 18 figs.

Ewing, H. E.—The Life-history and Habits of *Cheyletus seminivorous*, Packard. Journ. Econ. Entom., 1912, vol. 5, pp. 416-420.

Ghosh, C. C.—The Big Brown Cricket (*Brachytrypes achatinus*, Stoll.). Mem. Dept. Agric. India, Entom. Ser., 1912, vol. 4, pp. 161-182, plt. x and 4 figs.

Hammar, A. G.—Life-history Studies on the Codling Moth in Michigan. U.S. Dept. Agric., Bur. of Entom., Bull. No. 115, pt. 1, 1912, pp. vi + 86, 3 plts. and 22 figs.

Hancock, J. L.—*Tetriginae* (*Acridiinae*) in the Agricultural Research Institute, Pusa, Bihar, with Descriptions of New Species. Mem. Dept. Agric. India, Entom. Ser., 1912, vol. 4, No. 2, pp. 131-160.

Hindle, E., and G. Merriman.—The Sensory Perceptions of *Argas persicus* (Oken). Parasitology, 1912, vol. 5, pp. 203-216.

Hood, J. D.—A new Genus and three new Species of North American Thysanoptera. Psyche, 1912, vol. 19, pp. 113-118, plts. 8, 9.

Houser, J. S.—*Sciara sciophila* larvae congregating in chains. Journ. Econ. Entom., 1912, vol. 5, p. 399.

Howard, L. O.—The Activity of *Prospaltella berlesei*, Howard, against *Diaspis pentagona*, Targ. in Italy. Journ. Econ. Entom., 1912, pp. 325-328.

Karny, H.—On the Genera *Liothrips* and *Hoodia*. Proc. Entom. Soc. Lond., 1912, pp. 470-475.

King, H. H.—Observations on the Occurrence of *Glossina* in the Mongalla Province of the Anglo-Egyptian Sudan. Bull. Entom. Research, 1912, vol. 3, pp. 89-93, 1 map.

Rehn, J. A. G.—Notes on African Orthoptera of the Families *Mantidae* and *Phasmidae* in the United States National Museum, with Descriptions of New Species. Proc. U.S. Nat. Mus., 1912, vol. 42, pp. 451-475, 17 figs.

Rohiver, S. A.—Studies on the Woodwasp Superfamily *Oryssoidea*, with Descriptions of New Species. Proc. U.S. Nat. Mus., 1912, vol. 43, pp. 141-158, plts. 32, 33 and 6 figs.

Rohiver, S. A.—Notes on Sawflies, with Descriptions of New Species. Ibid., pp. 205-251.

Smith, H. S.—The Chalcidoid Genus *Perilampus* and its relation to the Problem of Parasite Introduction. U.S. Dept. Agric., Bur. of Entom., Tech. Ser. No. 19, pt. iv, 1912, pp. 33-69, 8 figs.

Swanton, E. W.—New and Rare British Plant-Galls. Journ. Bot., 1912, pp. 283, 284.

Viereck, H. L.—Contributions to our knowledge of Bees and Ichneumon-flies, including the Descriptions of Twenty-one New Genera and Fifty-seven New Species of Ichneumon-flies. Proc. U.S. Nat. Mus., 1912, vol. 42, pp. 613-648.

Webb, J. L.—A Preliminary Synopsis of Cerambycoid Larvae. U.S. Dept. Agric., Bur. of Entom., Tech. Ser., No. 20, pt. v, 1912, pp. 149-155, 1 plt.

Webster, R. L.—The Number of Moults of the Pear Slug, *Caliroa cerasi*, L. Journ. N.Y. Entom. Soc., 1912, vol. 20, pp. 125-130.

Wilson, C. B.—Dragon Flies of the Cumberland Valley in Kentucky and Tennessee. Proc. U.S. Nat. Mus., 1912, vol. 43, pp. 189-200.

Woodworth, C. W.—Check List of California Insects. II. Mon. Bull. State Comms. Hort. Sacr., Cal., 1912, vol. 1, pp. 782-790.

IV.—Agriculture and Horticulture.

Back, E. A. and W. J. Price, Jr.—Stop-back of Peach. Journ. Econ. Entom., 1912, vol. 5, pp. 329-334.

Ballou, H. A.—Scale Insects and their Insect Parasites. W. I. Bull., 1912, vol. 12, pp. 448-463.

Ballou, H. A.—A Report on Observations on Scale Insects. Ibid., pp. 560-562.

Bovell, J. R.—The Use of Entomogenous Fungi on Scale Insects in Barbados. W. I. Bull., 1912, vol. 12, pp. 399-402.

Chittenden, F. H.—The Broad-bean Weevil (*Laria rufimana,* Boh.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 96, pt. v, 1912, pp. 59-82, 10 figs.

Cooley, R. A. and D. B. Swingle.—A Spraying Program for Montana Orchards. Montana Agric. Coll. Exp. Stat., Circ. 17, 1912, pp. 119-153, 12 figs.

Demuth, G. S.—Comb Honey. U.S. Dept. Agric., Far. Bull., 503, 1912, pp. 1-47, 20 figs.

Ewing, H. E.—Mites associated with the Oyster-Shell Scale. Psyche, 1912, vol. 19, pp. 121-134, 2 figs.

Ewing, H. E.—The Occurrence of the Citrus Red Spider, *Tetranychus mytilaspidis,* Riley, on Stone and Pomaceous Fruit Trees in Oregon. Journ. Econ. Entom., 1912, vol. 5, pp. 414, 415.

Fawcett, H. S.—The Potato Wart Disease. Mon. Bull. State Comms. Hort. Sacr., Cal., 1912, pp. 733-736, 2 figs.

Felt, E. P.—*Itonida inopis,* O.S. Journ. Econ. Entom., 1912, vol 5, pp. 268, 369.

French, Jr., C.—Destructive Scale Insects. Journ. Dept. Agric. Victoria, 1912, vol. 10, pp. 485, 486, 3 figs.

Gillette, C. P.—*Diabrotica virgifera,* Lec., as a Corn Root-worm. Journ. Econ. Entom., 1912, vol. 5, pp. 364-366, 7 figs.

Gillette, C. P.—*Cleonus canescens,* Lec., as a Fruit Tree Pest. Ibid., p. 367, 1 fig.

Howlett, F. M.—The effect of Oil of Citronella on two species of *Dacus.* Proc. Entom. Soc. Lond., 1912, pp. 412-418, plts. xxxix, xl.

Hunter, W. D.—Two Destructive Texas Ants. U.S. Dept. Agric., Bur. of Entom., Circ. No. 148, 1912, pp. 1-7.

Hyslop, J. A.—The False Wireworms of the Pacific North-West. U.S. Dept. Agric., Bur. of Entom., Bull. No. 95, pt. v, 1912, pp. 73-87, 6 figs.

Jepson, F. P.—The Rhinoceros Beetle (*Oryctes rhinoceros,* Linn.) in Samoa. Fiji Dept. Agric., Suva, Bull. No. 3, 1912, pp. 1-25, plts. i-vii.

McGregor, E. A.—The Red Spider on Cotton. U.S. Dept. Agric., Bur. of Entom., Circ. No. 150, 1912, pp. 1-13, 5 figs.

Merrill, G. E.—The Alfalfa Weevil Situation. Mon. Bull. State Comms. Hort. Sacr., Cal., 1912, vol. 1, pp. 765-778, 26 figs.

Mexican Cotton-Boll Weevil.—Pp. 188, 22 plts. and 34 figs. Washington. 1912.

Quaintance, A. L. and W. M. Scott.—The more important Insect and Fungous Enemies of the Fruit and Foliage of the Apple. U.S. Dept. Agric., Far. Bull., 492, 1912, pp. 1-48, 21 figs.

Rixford, G. P.—Fructification of the Fig by *Blastophaga*. Journ. Econ. Entom., 1912, vol. 5, pp. 349-355.

Rorer, J. B.—Bud Rot of the Cocoa-nut Palm. W. I. Bull., 1912, vol. 12, pp. 443-445.

Rosenfeld, A. H.—Insects and Spiders in Spanish Moss. Journ. Econ. Entom., 1912, vol. 5, pp. 338, 339.

Safro, V. I.—Lime-Sulphur Wash an Inefficient Ovicide for Codling Moth. Journ. Econ. Entom., 1912, vol. 5, pp. 385-395.

South, F. W.—Further Notes on the Fungus Parasites of Scale Insects. W. I. Bull., 1912, vol. 12, pp. 403-412.

South, F. W.—Some Root Diseases of Permanent Crops in the West Indies. Ibid., pp. 479-498.

Theobald, F. V.—A New Strawberry Aphis. Entom., 1912, vol. 45, pp. 223-224.

Urich, F. W.—Cocoa-nut Palm Insects in Trinidad. W. I. Bull., 1912, vol. 12, pp. 446-448.

Webster, F. M.—The Clover Mite (*Bryobia Pratensis*, Garman.). U.S. Dept. Agric., Bur. of Entom., Circ. No. 158, 1912, pp. 1-5, 3 figs.

Webster, F. M.—The So-called "Curlew Bug" (*Sphenophorus callosus*, Oliv.). U.S. Dept. Agric., Bur. of Entom., Bull., No. 95, pt. iv, 1912, pp. 53-71, plts. vi-ix and 6 figs.

Webster, R. L.—Some Further Notes on the White-head Army Worm, *Meliana albilinea*, Hubner. Journ. Econ. Entom., 1912, vol. 5, pp. 335, 336.

Went, F. A. F. C.—Does the Sereh Disease exist in the West Indies, more especially in Trinidad? W. I. Bull., 1912, vol. 12, pp. 554-560.

Whitney, B. B.—Some Undesirable Immigrants from Japan. Mon. Bull. State Comms. Hort. Sacr., Cal., 1912, pp. 737-739, 4 figs.

V.—Forestry.

Doane, R. W.—Some Insect Pests of the California Live Oaks. Journ. Econ. Entom., 1912, vol. 5, pp. 346-348.

Hopkins, A. D.—Damage to the Wood of Fire-killed Douglas Fir, and methods of preventing losses, in Western Washington and Oregon. U.S. Dept. Agric., Bur. of Entom., 1912, Circ. No. 159, pp. 1-4.

Imms, A. D.—Insect Invasions and Methods of Control in American Coniferous Forests. Indian Forester, 1912, pp. 400-403.

Patch, Edith M.—Woolly Aphid migrating from Elm to Mountain Ash. Journ. Econ. Entom., 1912, vol. 5, pp. 395-398, plt. 10.

VI.—Fisheries.

VII.—Medicine.

Brues, C. T. and P. A. E. Sheppard.—The Possible Etiological Relation of Certain Biting Insects to the Spread of Infantile Paralysis. Journ. Econ. Entom., 1912, vol. 5, pp. 305-324.

Fantham, H. B.—Note on the Occurrence and Distribution of *Herpetomonas pediculi.* Ann Trop. Med. and Paras., 1912, vol. 6, pp. 403-404.

Herms, W. B.—Economic Entomology from the view point of the Sanitarian. Journ. Econ. Entom., 1912, vol. 5, pp. 355-357.

Wise, K. S. and E. P. Minnett.—Experiments with crude carbolic acid as a Larvicide in British Guiana. Ann. Trop. Med. and Paras., 1912, vol. 6, pp. 327-330.

VIII.—Animal Diseases, etc.

Moore, W.—The Tick Problem in South Africa. Journ. Econ. Entom., 1912, vol. 5, pp. 377-384, 1 fig.

Patton, W. S.—*Spirochaeta ctenocephali,* sp. nov., Parasitic in the Alimentary Tract of the Indian Dog Flea, *Ctenocephalus felis.* Ann. Trop. Med. and Paras., 1912, vol. 6, pp. 357-359, 1 fig.

Robertson, W. A. N.—The Etiology of Contagious Diseases. Journ. Dept. Agric. Victoria, 1912, vol. 10, pp. 489-503, 34 figs.

PROCEEDINGS

OF THE

ASSOCIATION OF ECONOMIC BIOLOGISTS.

ELEVENTH GENERAL MEETING, March 28th and 29th, 1912.

THURSDAY, MARCH 28TH, 1912.

The Eleventh General Meeting was held at the Royal College of Science, Dublin.

Morning Meeting, in the Zoological Lecture Theatre: Attendance 40-50 members and visitors.

The Chair was taken by the President of the Association, Prof. Geo. H. Carpenter, B.Sc., M.R.I.A., F.E.S., at 10.30 a.m.

1. The President, welcoming the Association to Dublin, declared the 11th General Meeting open. Proceeding, he read his paper on "Biological Training for Agricultural Students" (*vide* Journal, 1912, p. 37). In opening the discussion, Prof. McWeeney paid a tribute to the soundness of the scheme outlined by Prof. Carpenter, and commented upon the excellence of the spirit underlying it.

Prof. J. R. Campbell, who followed, urged the importance of biological study in furthering the development of agriculture, and stated his belief that the necessity for such work was now becoming generally recognised.

Dr. R. Stewart MacDougall agreed, but pointed out that in the successful prosecution of scientific agriculture many branches of knowledge must be drawn upon. He entirely approved of the attitude of Prof. Carpenter with regard to the importance of field work to agricultural students at all stages of their training.

Prof. Carpenter briefly replied.

2. Dr. Stewart MacDougall then read his paper on "Parthenogenesis in *Nematus erichsonii.*"

Mr. Forbes discussed the paper from the point of view of the practical forester, referring to his experience of the pest in Great Britain and Ireland.

Mr. Mangan drew attention to the economic importance of the part played by the parasites of *Nematus,* and

Dr. Hinchcliff instituted comparisons with the gooseberry saw-fly, and suggested the possibility of parthenogenesis in this species. He was followed by

Prof. Carpenter, who made suggestions as to experiments with regard to the further investigation of the methods of reproduction in *Nematus*.

The author, in his reply, made reference to his further researches on the pest.

3. Dr. G. H. Pethybridge presented a communication on "The Methods employed in testing grass seeds" (*vide* Journal, 1912, p. 41).

Prof. J. R. Campbell referred to the great importance of the questions raised in the paper. He pointed out that, up to the present, complete agreement as to the best methods of seed-testing had not been attained, and made reference to the attitude of wholesale seed-merchants.

Prof. T. Johnson spoke to the same effect, but gave his support to the "Irish" system.

Mr. Varian also spoke.

The author replied. Dr. Hänschell and Mr. O. B. Williams were elected Ordinary Members of the Association.

The Meeting then adjourned.

Afternoon Meeting in the Zoological Lecture Theatre: attendance 40-50 members and visitors. The President in the Chair.

4. Mr. P. A. Murphy read a "Preliminary Note on the Culture of *Phytophthora infestans* (the Potato Blight fungus), with special reference to the formation of oospores."

The author gave the results of cultural experiments with the fungus which causes Potato Blight, particular attention being paid to the vexed question as to whether it produces oospores or not. A short account was first given of the work of previous investigators; and the author of the paper then dealt in some detail with the experimental cultures carried out by himself in conjunction with Dr. Pethybridge at the Department's Research Station for Potato Diseases at Clifden, Co. Galway. The growth and reproduction of the fungus on eight different artificial media were briefly described, and specimens of the cultures were exhibited. Clinton's medium, composed chiefly of crushed oats, proved to be the most favourable one, and on it not only conidia, but also the oogonia and oospores were produced. These are probably formed sexually, although definite antheridia have not yet been clearly observed. The results confirm the work carried out by Dr. Clinton in U.S.A. a short time ago.

Such resting spores have not yet been found in the field with

certainty, though bodies very like them have been seen from time to time. But since it is now certain that the fungus does produce them in artificial culture, it is highly probable that they must occur on the dead and dying potatoe plants in the field; and the attacks of potato blight from which we suffer year after year, originate from such resting spores which have been lying in the soil over winter.

Pure cultures of the fungus and microscopical preparations of the oogonia and oospores were exhibited.

Prof. E. J. McWeeney put questions as to the methods employed by the author in his researches, while

Prof. T. Johnson referred to the author's virtual confirmation of W. G. Smith's contention as to the occurrence of oospores in *P. infestans.*

Dr. Pethybridge explained the origin and history of Mr. Murphy's work, and pointed out the theoretical and practical significance of his communication.

Mr. Murphy replied. Microscopic preparations of the oogonia and oospore of the fungus were subsequently exhibited in the Zoological Laboratory.

5. A paper by Mr. Walter E. Collinge, on "Some Observations on the Food of Birds," was read, in the absence of the author, by the President. The author stated that "during the past few years there has been an increased interest evidenced in investigations upon the food of certain wild birds, and at the present time there were a number of workers engaged upon the task of assigning more exactly the economic importance of a large number of species.

Such work, when completed, must have a considerable effect upon the efforts of farmers, fruit-growers, etc., in their endeavours to protect or destroy particular species, provided the work is sufficiently thorough and has extended over a considerable area of the country and throughout the different seasons of the year.

At the outset he stated a fact, that is far too often overlooked by many who advocate the indiscriminate protection of wild birds, that there are certain species which are distinctly beneficial to the farmer, fruit-grower, and gardener, if not allowed to become too numerous, but as soon as their numbers exceed a certain limit they become equally injurious and cannot be regarded as other than enemies.

As yet neither the farmer nor bird-lover have paid sufficient attention to sifting the facts and separating the same from prejudice and hearsay. We want much more detailed information as to the food of different birds, and the collection of this information must

extend over the whole twelve months of the year and for successive years. It is only by carefully considering and judiciously weighing the information thus obtained that we shall ever arrive at sound conclusions.

No one, I think, will deny that birds as a class are much more beneficial than they are injurious to the agriculturist. This is openly granted by farmers and others, but it is with reference to, comparatively speaking, a few species only that so much diversity of opinion exists.

We have about two hundred and eighty species of British birds, a fair percentage of which are so rare or small in numbers that they do not affect the subject under consideration. In the same manner, all those species aquatic or littoral in their habits may be left out of consideration. Thus we reduce the list down to about eighty-five species, of which fifty may be said to feed exclusively upon insect life—such, for instance, as the swift, swallow, martin, flycatchers, wagtails.

The problem whether a certain species is beneficial or injurious to the agriculturist or horticulturist, is by no means an easy one to decide, for it does not necessarily follow that because a bird is insectivorous it is beneficial, indeed there are many birds whose food consists of more beneficial insects than injurious ones. Graminivorous birds, generally speaking, are injurious. At first sight it might appear that birds feeding upon the seeds of weeds are beneficial, but the fact that obnoxious weeds are largely distributed by the agency of birds, and that such weeds are never completely eliminated by the action of birds, must be borne in mind. Of the omnivorous birds considerable more information is desirable before any verdict is passed.

There is one particular point I should like to emphasize as being of special importance in any investigation upon the food of a particular species of birds, and that is the exact nature of the food during the breeding season. We already know of numerous instances where birds that are injurious to crops for the greater part of the year, feeding their young upon insect larvae and slugs. The difficulty of rightly estimating the precise status of such birds is no easy task. Again, birds that breed early in the year feed upon the first broods of various species of insects, thus affording a very important check, often, no doubt, preventing a plague.

Work which I have recently finished offers evidence of a conclusive nature as regards the rook, starling, thrush, blackbird, and bullfinch.

Respecting this last mentioned species, the examination of some hundreds of specimens extending over the whole of the year, and collected over a wide area, show it to be a most injurious species and a distinct enemy to the fruit-grower." A lengthy discussion ensued.

Mr. Mangan referred to the interest of Mr. Collinge's work during recent years. He pointed out the extreme care needed in dealing with this question, and expressed his opinion that the ordinary method of determining the economic status of birds mainly upon the result of the examination of the crops of these birds could not be regarded as wholly satisfactory.

Prof. J. R. Campbell spoke to the same effect.

Dr. Pethybridge, Mr. Garnsey, and Dr. MacDougall contributed to the discussion, Dr. MacDougall urging the necessity for long and continued observations and experiments, with due regard to questions of season and local systems of rotation.

Messrs. Adams and Varian also spoke, and

Prof. Carpenter summarised the requirements of work in this important field of investigation.

The President then brought to the notice of the Meeting a letter received from Prof. Priestley, of Leeds, having reference to the maintenance, at a Central Office, of a Card Catalogue of Fungus Diseases of Plants. The matter was recommended to the consideration of the Association.

The Meeting was then adjourned, and by the kind hospitality of the Zoological division of the Royal College of Science, tea was served in the Laboratories. Members subsequently inspected the Laboratories of the new College, and the Collections in the National Museum.

Friday, March 29th, 1912.

Morning Meeting, in the Zoological Lecture Theatre; 50 members and visitors present.

On the invitation of the President, in the Chair,

6. Mr. H. Hunter read his paper on "Cereal Breeding in Ireland."

Prof. Campbell, in discussing the paper, referred to the importance of the work being done in Ireland in connection with Barley and other Cereal crops.

7. A paper by Mr. Cecil H. Hooper on "Experiments on the Pollination of our Hardy Plants" was then read by Dr. Pethybridge on behalf of the author.

The President raised the question of the effect of cross-pollination upon the stability of the variety. His remarks were dealt with by

Sir Frederick Moore, who gave an account of the general principles of fruit-growing practice. He corroborated several points mentioned in the paper, and referred to other points needing scientific investigation.

Mr. Adams discussed the paper at some length, bringing forward the results of personal observations on related questions.

Mr. Dickson spoke on the question of the vitality of pollen.

Mr. Mangan referred to the influence on the fruit crop of the "Isle of Wight" disease of bees.

8. Dr. G. H. Pethybridge communicated a "Preliminary Note on Two New Forms of Rot in the Potato Tuber." Dr. G. H. Pethybridge gave an illustrated account of two hitherto undescribed forms of rot in the potato tuber which are the outcome of some of the latest of the special investigations carried out at the research station established at Clifden, Co. Galway, by the Department of Agriculture in 1909, for the closer study of the various diseases of the potato, the results of earlier investigations having been published annually for the past three years in the Department's Journal. The first type of rot, which had been provisionally named the "doubtful" tuber rot, causes very serious loss in the crops of tubers not only in the west but also in the north of Ireland. The cause of this rot has been discovered to be a fungus which enters the tuber at its heel end, and very quickly causes its complete decay. The fungus itself appears to be closely allied to, but is not identical with, that causing the ordinary potato blight, it certainly belongs to the genus *Phyphthora*. Its life-history is being studied in detail, and when this is more fully known, an attempt will be made to discover some means by which the disease may be successfully circumvented. The second type of rot is characterised by the formation of sunken, circular, black spots of diseased tissue in the body of the tuber which spread and coalesce, finally causing its destruction. This type of rot has been provisionally called "Black pit-rot," and it affects the potatoes chiefly when they are in store in pits, whereas the other form of rot attacks the tubers in the field before they are pitted. The actual cause of the "black pit-rot" has not yet been definitely ascertained, but it also appears to be of a fungoid, not a bacterial, nature. Investigations on both of these new types of rot are being actively pursued.

Prof. Johnson discussed the author's results, and was followed

by Prof. Campbell, who referred to the importance of the work in connection with the Potato disease being carried out by Dr. Pethybridge at the new Experiment Station in the West of Ireland.

Dr. Pethybridge replied.

9. Prof. McWeeney read a paper on "A Fungus Isolated from a Case of Human Skin Disease." Prof. E. J. McWeeney (National University) read a paper upon a "Hyphomycete," isolated from a case of human skin disease, which took the form of swollen and reddened patches on the skin of the forearm of a man, who, about a fortnight previously had been engaged in skinning a sheep. The plaques were reddened, raised, and presented small foci of suppuration. From the pus of one of these foci the fungus now shown was isolated in pure cultivation. It consisted of mycelium between 5 and 8 μ wide, abundantly septate, and branched. The ends of the branches tended to break up into chains of Conidia, which were at first squarish, but afterwards became rounded. These Conidia were about the same thickness as the mycelium. They often showed a tendency to sprout whilst *in situ,* emitting thin germ-tubes, which gave the Conidial chains a very peculiar appearance. The older parts of the mycelium tended to break up into somewhat large square-shaped chlamyds-spores with very thick coats. The fungus was Gram-negative. Numerous nuclei could readily be demonstrated by Heidenhdin's iron-hamatoxylin. The fungus grew well upon solid and liquid media, somewhat better on addition of sugar to the broth or Agar. The largest colonies were obtained by addition of maltose. On potato and Agar it produced a whitish growth, at first stellate and then wrinkled, somewhat resembling cerebral convolutions. Older colonies assumed a chalky-white appearance, owing to aerial spore formation. In broth the submerged spores produced white fluffy balls of mycelium. A few days after the vessel was shaken, so as to detach the spores, numerous young stellate plants appeared on the walls of the containing vessel. The speaker had not yet succeeded in forcing this fungus to produce spores by a sexual method. He had started a number of cultivations under anaerobic conditions for the purpose, but there had not yet been time to obtain a definite result. He was, as yet, uncertain as to the true biological position of the fungus, and could only say it was certainly not a *Sporotrichum*. He had been able to satisfy himself of this by comparing his cultures with those of *Sporotrichum beurmanni,* kindly sent to him by Dr. James Ritchie, of Edinburgh.

The speaker concluded by saying that he had not himself seen the case from which the fungus had been isolated, and had not

intended making any communication on the subject at the present stage, when his investigations were as yet so incomplete. He thought, however, that the meeting of the Association of Economic Biologists afforded a good opportunity for obtaining the opinion of Cryptogamic Botanists on the matter, in which he was much interested, and he invited suggestions as to the proper position of this fungus, and how best to encourage the production of sexually-produced spores.

The paper was illustrated by numerous pure cultivations, drawings and micro-photographs. The author sought for information as to the identity of the fungus described by him, and for suggestions as to its further investigation. In the discussion

The President referred to the importance and interest of the communication.

Dr. Pethybridge outlined methods which suggested themselves as of probable value in investigating the fungus.

Prof. Mettam expressed the opinion that the disease described was a form of animal "ring-worm."

Prof. McWeeney replied. Cultures and microscopical preparations of the fungus were afterwards exhibited.

This paper concluded the Scientific business of the Meeting.

The President then read a letter received from Mr. T. P. Gill, Secretary of the Department of Agriculture and Technical Instruction for Ireland, expressing regret at his unavoidable absence from the Meeting. Mr. Gill referred to the national importance of the study of Economic Biology, and submitted that the attitude of the Department of Agriculture and Technical Instruction towards the questions of seed-testing, potato-disease, cereal-breeding and fisheries was evidence of the recognition, by the Department, of the value of biological work.

The President directed the Secretaries to convey the thanks of the Association to Mr. Gill for his letter.

Dr. S. E. Chandler then proposed a vote of thanks to the Department for the facilities so generously accorded to the Association for the General Meeting. The proposal was seconded by Mr. Garnsey, of the English Board of Agriculture and Fisheries, and carried *nem. con.*

Mr. Adams, on behalf of the visitors, proposed; and

Miss McDowell, on behalf of the students, seconded, a vote of thanks to the Association for opportunities afforded of attending the Meeting. Carried.

The Meeting then adjourned.

Friday Afternoon.

A small party of members of the Association, under the guidance of the President, visited the Albert Agricultural College, Glasnevin, and the Royal Botanic Gardens.

Albert Agricultural College.—The aims and general working of the College were explained by the officials. The domestic arrangements for the accommodation of the students were then inspected, and a tour made through the laboratories, lecture hall and workshops. The party was then conducted over the Farm by Mr. Drew. The herds of cattle and pedigree pigs maintained by the Department were visited, Mr. Drew explaining the importance of the animals in connection with the scheme for the improvement of Irish stock. The poultry runs were also inspected. Later, the system of rotation adopted on the Farm was explained, and a visit was made to the Orchard and Gardens. The party was subsequently entertained at tea by kindness of the Principal, Geo. Stephenson, Esq.

Royal Botanic Gardens.—In visiting the Royal Botanic Gardens, Glasnevin, the Association had the advantage of the conduct of the Director, Sir Frederick Moore. The various houses were examined, the Director pointing out the special features of the Gardens. Particular reference was made to the Collections of Cycads, Palms, Ferns, Alpines, Water Plants, Droseras, and Cinerarias. The collection of original varieties of Narcissus was inspected, and attention called to notable plants in the Pinetum and neighbouring parts of the Gardens. The visit concluded at 7 p.m.

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THE

JOURNAL OF ECONOMIC BIOLOGY

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CONTENTS OF VOLUME VIII.

THE

JOURNAL OF ECONOMIC BIOLOGY.

THE TERRESTRIAL ISOPODA OF THE MIDLAND PLATEAU.

By

WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.

With 12 Figures.

Contents.

I.—Introduction.

For some years past I have been keeping a record of the Terrestrial Isopoda of the Midland Plateau, and in order that the same may be made more complete, it seems desirable to publish this preliminary list. There are two immediate reasons for so doing, viz., (1) many of the older workers and co-operators have passed away or ceased to take an active interest in the subject, so that new recruits are very desirable, and (2) a working synopsis may possibly induce some of the younger naturalists to turn their attention to this very interesting Order of animals.

In compiling these records I have laid myself under many obligations to numerous fellow-workers, and I here wish to express my sincere thanks to all of them for the willing assistance given.

My special thanks are due to Mr. Wilfred Mark Webb, for his kindness in loaning me the electros of the figures illustrating this paper.

II.—Classification.

Very little need be said under this heading. In the main I have followed Professor Sars, and the Family and Generic characters here used are largely based on those in his admirable work on the *Crustacea of Norway*. All our British species fall into two sections, Ligiae and Onisci, and the different genera are so closely allied that the question of family distinction must remain, to a large extent, an arbitrary one.

There are no doubt many more species to add to the British list and to that of the Midland Plateau. From this latter area I should at any time welcome specimens. These should be placed, immediately upon collecting, in bottles or tubes with a little alcohol in, and a piece of cotton wool to prevent damage to the specimens in transit. The dates, locality and habitat should in all cases be stated.

III.—Economic Importance.

Garden crops, flower gardens, and field crops frequently suffer considerable injury by being attacked by woodlice, but it is perhaps in ferneries, hothouses, and conservatories that they occasion the greatest damage.

The economic side of these interesting animals has hitherto only been very casually studied, but apart from their injury to plant-life, they may, owing to the fact of their feeding upon house refuse and other decomposing matter and frequently making their way into houses, especially keeping cellars, larders, etc., possibly aid in the dissemination of various diseases. Pierce[1] records finding a dead rat near the house almost entirely eaten by woodlice, and I have on more than one occasion observed them feeding upon dead earthworms and once on the remains of a dead bird.

Miss Richardson (26) records injuries to cucumbers and hothouse vegetables, date palms and mushrooms in the United States. Garman[2] cites injuries to young cucumbers and lettuce in greenhouses. Theobald[3] records them damaging hops.

Pierce,[1] who has paid particular attention to the economic aspect in the United States, states that at Dallas, cotton plants were damaged and many of the seedlings of the second planting were killed, by *Armadillidium vulgare*, Latr., and many gardens had suffered through attacks on the young sprouts of beans, peas,

[1] U. S. Dept. Agric., Bur. of Entom., Bull. No. 64, pt. ii, 1907.

[2] Kentucky Agric. Exp. Stat., Bull. 91, 1901.

[3] First Rpt. Econ. Zool., 1903.

tomatoes, and on rose bushes and other cultivated plants. Correspondents informed him of damage by the same species to roots of palmetto, butter beans, radishes, lettuce, mustard, potted plants, and also flower seeds. He also observed them on honeysuckle at various heights up to three feet, and on different trees to greater heights. The same writer records *Metoponorthus pruinosus*, Brandt, damaging cotton plants, but he notes, to the credit of *Porcellio laevis*, Latr., that in experiments with the eggs of the cattle tick (*Boophilus annulatus*, Say.), four woodlice, provided with over 300 eggs, devoured 153 at the rate of five and six a day. He also observed them on honeysuckle at various heights up to three feet, and on different trees to greater heights.

Popenoe[1] mentions *Armadillidium vulgare*, Latr., and *Porcellio laevis*, Koch, attacking mushrooms. "More frequently than at first might be thought," he states they are, "carried into the mushroom house in compost which has been allowed to stand aside. The heat of the manure is relished by them, and they collect in numbers, remaining there throughout the growth of the spawn, but becoming injurious with the first growth of the mushrooms." He further states that he has seen sowbugs collected in manure piles to such an extent that numbers aggregating a pint or more in quantity might have been collected from a shovelfull of material.

In my various Reports[2] I have recorded them damaging ferns and numerous plants under glass. In one case I know of, *Trichoniscus roseus*, Koch, was so numerous in a fernery that it was partially ruined by this species, and the whole of the rockery work had to be taken down and rebuilt, all the old soil, etc., being removed.

In another case very serious damage was occasioned by *Porcellio scaber*, Latr., in flower borders. During the daytime the woodlice secreted themselves between the soil and the tiles bordering the beds. When the tiles were lifted, thousands of specimens, both adult and young, were found.

Marrows often suffer from the attacks of *Oniscus asellus*, Linn., and *P. scaber*; I know of two or three cases where the frames have had to be entirely cleaned out and replanted. In another instance, potatoes were seriously damaged by these two species.

Armadillidium vulgare, Latr., I once met with in thousands, so plentiful were they that it was almost impossible to cultivate any plants in the particular borders, which extended over a considerable area.

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[1] U. S. Dept. Agric., Bur. of Entom., Circ. No. 155, 1912.

[2] Rpts. on Inj. Insects, 1904-1908.

So far as my observations go, the damage is always done at night, and it is surprising what numbers of such species as *Oniscus asellus*, Linn., *Porcellio scaber*, Latr., and *P. pictus*, Brandt, may be met with in ferneries, etc., on entering such places when dark, with a lantern.

Poisoned baits have long been regarded as the standard remedies. Potatoes cut into thin slices and covered with Paris green being very effective. Trapping with boards, wet grass, etc., is useful in conservatories. Dusting the soil, especially along the sides of tiles surrounding flower beds, with equal parts of Paris green and ground unslaked lime is an excellent remedy. Some of the fluid soil insecticides I have also found very effective.

IV.—Habits and Habitat

Woodlice are only found where moisture exists, in dark and damp situations in the vicinity of dwelling houses, such as cellars, outhouses, conservatories, around wells, cisterns, water barrels, rockeries, under boards, stones, and rubbish they are commonest: they also occur beneath the bark of dead and decaying trees, amongst decaying vegetable matter, moss, under stones, etc.

Moisture being the prime requisite to their well being, wet seasons, such as that of 1912, are exceedingly favourable to a rapid increase in their numbers.

Respecting the effect of natural and field conditions upon these crustaceans, Pierce (*op. cit.*) states that "susceptibility to varying conditions was very noticeable." In the case of *Armadillidum vulgare*, Latr., he states that on "May 25, at 7.30 a.m., a large number of sowbugs had gathered at baits. At 8 o'clock a sudden storm commenced to rise. The sowbugs seemed immediately conscious of danger, and hastened in all directions for the highest shelter possible, gaining protection on the fence and beneath the clapboards of the house. All were out of sight when the first drops of water fell. In April and May there was considerable rain, and during the periods of sunshine at whatever time of day, the sowbugs were to be seen everywhere, crawling over the sidewalks and pavements. April 23 and 24 the ground was drenched with water, and on the 25th dead sowbugs were to be found everywhere on the ground and on the sidewalks. On June 3 a similar observation was made in a spot where the water had stood for several days. By June 15 the intense heat had driven the sowbugs from the open so that few could be found in unprotected places.

Copulation was frequently noted out of doors during April and

May. The males may be distinguished from the females by their colours as well as by the specific sexual characters. They are a dark, slaty blue, while the females are lighter and have yellow markings.

The period of incubation in this species is long, between fifty-six and ninety-three days, according to the varying results obtained. As no individuals were secured in copula, the exact time of its duration was not recorded. The development of the eggs may be watched from the exterior. The females should be treated very carefully, but with a lens one may see on the ventral side, in the marsupium, the distinct form of the eggs, and may notice the increase in size and finally note the young embryos and the little white young. One experiment with ten females was most fruitful in giving data on this point. On May 8, June 16, and July 8 young had been produced, and on examination on July 26 all were found to be unfertilized except one, which had eggs apparent. On August 7 the fertile female produced a brood of young. This was 93 days after being placed in captivity. A male was admitted on July 26, and on September 30 a brood of young was produced. This would indicate a period of incubation of, at the most, sixty-eight days. In another experiment a female which had just produced a brood of young was placed with 3 males on August 7. On October 2 a brood of young was produced, making the period of incubation fifty-seven days. The number of young in a brood varied from 29 to 79.

The little isopods are pure white when they leave the marsupium. They have six pairs of legs. Within twenty-four hours of birth they moult, and still have only six pairs of legs. Between the fourteenth and eighteenth days another moult takes place, and the resulting third instar has seven pairs of legs. The young continue to grow and moult, having been observed in the act of moulting on the twenty-eight, thirty-sixth, fifty-eighth, and sixty-eighth days. After the first moult there is no regularity as to times of moulting in the brood, all depending on the food supply. After the first moult a slight darkening of the intestines is noted, and by the twenty-first day the sowbugs are of a gray colour throughout and under 3 mm. in length. In fifty-eight days they have not increased beyond 4 mm. in length. The greatest size of any found was 15 mm. This specimen was probably several years old. Females not over 7 mm. are capable of reproduction.

Before moulting, the body of all sowbugs becomes a very dirty gray colour. The act of moulting is peculiar. At first a white border indicating the loosening of the old skin appears at the front edge of the fifth free thoracic segment, then another on the sixth,

and still another on the seventh. Finally, the entire posterior half of the skin is free and the isopod steps out of it. This process consumes about twenty-four hours, and when completed the posterior part of the body is of fresh slate colour, while the old anterior part appears very dull. Following the first stage of the moult the anterior segments commence to loosen and are slid forward. The dorsum of the third and fourth thoracic segments is loosened before the legs of these segments are released. From then on the last two pairs of legs in the very young and the last three in later stages are used to hold the animal in position. The anterior legs are not available for use for some time after they are free. The antennae are withdrawn last.

Regeneration of parts takes place in the antennae and legs. Several times individuals with aborted members were noticed. These latter would gradually attain full length, then budding of the succeeding segment would be noted, and finally this member would be normal. The regenerated part is white for some time."

Casserley (36, 37) has made many interesting observations on the moulting of the same species.

Specimens of *Porcellio scaber*, Latr., which I have kept in captivity for some time had broods of 12 to 36 young. The moulting is similar to that described by Pierce, but the metamorphosis is more rapid. In *Metoponorthus pruinosus*, Brandt, Pierce mentions that "reproduction and development is very rapid, much more so than in either *Armadillidium* or *Porcellio*. One pair produced four broods of young in sixty-two days, there being seventeen, sixteen, and twenty-one days between broods. The broods are small. The young grow so rapidly that in two months they are one-half as large as their parents. They moult frequently."

Specimens of *Platyarthrus hoffmannseggii*, Brandt, which I kept in captivity for upwards of two years did not breed at all, but only one individual died. They were kept in an ants' nest made between two sheets of glass, as recommended by Lord Avebury. During the greater part of the time they occupied a special portion of the nest and seldom left it. We used to term this particular part the cemetery, for close by the ants buried any of their number that died, but I was never able to satisfy myself that the woodlice fed upon these dead specimens. Occasionally we thought they ate the fungi which from time to time appeared in the nest and also an alga which made its appearance. One specimen died about nine months after stocking the nest and was devoured by his relations.

Concerning the behaviour of various species during the winter, I have noticed in an outhouse that both *Oniscus asellus*, Linn., and

Porcellio scaber, Latr., were much more plentiful here during the winter than in the summer, and once I observed in the dusk of the day, early in the spring, large numbers of both species making their way into the garden. On examining the edging tiles around the flower beds, numerous specimens were found which were certainly not there a few days before. Previous to this I had frequently noticed a few dead examples on the walk, which probably had come out too soon and been killed either by the frost or wet.

Armadillidum vulgare, on the other hand, remains at the roots of plants seven and eight inches below the surface, tightly rolled up all through the winter, the earliest record I have for a specimen on the surface is April 12th.

V.—Systematic.

Order **Isopoda**, Latreille.

Arthrostraca without distinct carapace, first thoracic somite (rarely also the second) coalesced with the cephalon, body usually broad and more or less arched. Seven free thoracic segments, thoracic limbs without exopodites. Lamellar legs functioning as branchiae on the short-ringed, often reduced abdomen.

Sub-order **Oniscoida**, G. O. Sars.

Body more or less depressed, oval or oblong in form, capable in some cases, of being rolled into a ball. Cephalon small, more or less sunk into the 1st segment of the mesosome, no true rostrum, lateral portions more or less expanded. Mesosome composed of 7 well-defined segments, laterally expanded. Metasome usually divided into 6 well-defined segments, lateral plates (epimeral) may be expanded, the last two anterior ones usually not so. The 1st pair of antennae vestigial. The 2nd pair of antennae composed of a 5-jointed peduncle and jointed flagellum. Mandibles without palps. Six pairs of metosomal appendages, the anterior 5 being adapted for air-breathing. Last pair of appendages represent the uropoda, in certain genera (*Porcellio* and *Armadillidium*) the two anterior appendages contain pseudo-tracheae in pleopods.

Section I.—**Ligiae.**

Exopodites and endopodites of uropodo similar in shape.

Fam. **Ligiidae**.

Cephalon without lateral lobes. Eyes well developed or wanting. Flagellum of antenna with 10 or more joints. External sexual appendages in male double. Uropoda wholly exposed.

Genus **Ligidium**, Brandt, 1833.

Body oblong, rather convex, metasome attenuated.

Cephalon evenly rounded in front. Lateral plates of mesosome clearly defined. Eyes large and convex. Flagellum of antenna with 10 or more joints. Uropoda small.

L. hypnorum (Cuvier).

Oniscus hypnorum, Cuvier: Journ. d'hist. nat., 1792, vol. 2, pl. 26, figs. 3-5.
Ligidium hypnorum, Budde-Lund: Crustac. Isop. Terr., 1885, p. 254; Sars, Crust. Norw., 1898, vol. 2, p. 158, plt. 71.

This species was first recorded as British by the Rev. T. R. R. Stebbing (32) in 1873, who obtained specimens in the neighbourhood of Copthorne Common, Surrey. Webb (37) has since announced its discovery in Essex, and I am now able to record its occurrence in the Midlands.

The long-jointed flagellum of the antenna and the peculiar structure of the uropoda at once distinguish this species from any other occurring in the British Isles. Length of adult 9 mm.

Hab.—Henley-in-Arden, Warwickshire.

Fam. **Trichoniscidae**.

Body more or less elongated. Cephalon with small lateral plates. Eyes small or absent, appendages of uropoda partly covered; flagellum of antennae with less than 10 joints.

Genus **Trichoniscus**, Brandt, 1833.

Flagellum with 4-7 joints (rarely 3). Compound eyes.

T. pusillus, Brandt.

Trichoniscus pusillus, Brandt. Bull. Soc. Nat., Moscow, 1833, vol. 6, p 174, pl. 4, fig. 9; Sars, Crust. Norw., 1908, vol. 2, p. 161, plt. 72, fig. 1.

This, one of the smallest terrestrial species we have in this country, is of a dark reddish-brown colour, smooth and shining, and punctated with minute white blotches. There are usually 4 joints to the flagellum. Length of adult 4 mm.

Hab.—Henley-in-Arden and Claverdon, Warwickshire; near Worcester.

Fig. 1.—*Trichoniscus pusillus*, Brandt.

T. vividus, Koch.

Itea vivida, Koch: Deutsch. Crustacean, etc., 1840, pt. 34.

This species somewhat resembles the former one, although it is broader in proportion in the thoracic region. Further, it is twice as large as *T. pusillus*. The antennae are void of the bristles present in all other species of this genus, and the number of joints of the flagellum varies from 5 to 7.

Hitherto this species has only been recorded from Ireland, so far as known in the United Kingdom. Length of adult 8 mm.

Hab.—Botanical Gardens, Edgbaston.

T. roseus (Koch).

Itea rosea, Koch, Deutsch. Crustaceen, etc., pt, 22, pl. xvi.
Trichoniscus roseus, Sars, Crust. Norw., 1898, vol. 2, p. 163, pl. 73, fig. 1.

This species is easily distinguished from any other of this genus by its coral pink colour and the broken light-yellowish mid-dorsal stripe. On most segments there are three or more transverse rows of tubercles. It is larger than *T. pusillus* and slightly broader in the thoracic region. There are four joints only on the flagellum of the antenna. Length of adult 5 mm.

Bagnall (4) points out that the specimens found in conservatories, etc., are almost invariably more beautifully and richly coloured than those found outside, which agrees with my own observations.

Hab.—Edgbaston, Birmingham; Henley-in-Arden; Studley, Warwickshire (W. B. Grove!); Worcester.

Genus **Trichoniscoides**, G. O. Sars, 1898.

Lateral plates of thoracic segments not prominent, and with serrated margins; abdomen narrow; eyes simple or absent; flagellum of antenna with 4 joints.

T. albidus (Budde-Lund).

Trichoniscus albidus, Budde-Lund; Pros. Crustac. Isop. Terr., 1879, p. 9.

Trichoniscus albidus, Sars, Crust. Norw., 1898, vol. 2, p. 165, pl. 73, fig. 2.

This pretty little species may be distinguished from the different species of *Trichoniscus* and *Haplophthalmus* by its colour and the serrated margins of the lateral plates of the thoracic segments. Length of adult, 4 mm.

Hab.—Henley-in-Arden, Warwickshire.

Genus **Haplophthalmus**, Schobl, 1860.

Body elongated, gradually narrowing in postero-thoracic and abdominal region. Lateral plates of the head well developed. Side plates of mesosome expanded and apart. Eyes very small and simple. Flagellum of antenna 3-jointed.

H. mengii (Zaddach).

Itea mengii, Zaddach, Synops. Crust. Prussic. Prodromus, 1844, p. 16.

Haplophthalmus mengii, Budde-Lund, Crust. Isop. Terr., 1885, p. 250; Sars, Crust. Norw., 1898, vol. 2, p. 167, plt. 74, fig. 1.

May be distinguished from *H. danicus* by the possession of longitudinal finely crenulated ribs passing down the body, and by having two very prominent ribs on the back of the third segment of the metasome. Length of adult 3 mm.

Hab.—Bromsgrove and Sutton Coldfield.

H. danicus, Budde-Lund.

Haplophthalmus danicus, Budde-Lund, Pros. Crustac. Isop. Terr., 1879, p. 9; Crustac. Isop. Terr., 1885, p. 250; Sars, Crust. Norw., 1898, vol. 2, p. 168, plt. 74, fig. 2.

The present species may be distinguished from *H. mengii* by the different sculpturing of the mesosome and the absence of the two

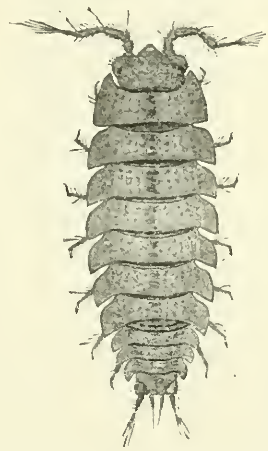

Fig. 2.—*Haplophthalmus danicus*, Budde-Lund.

conspicuous crenulated ribs on the third segment of the metasome. Further, it is larger, adults measuring 4 mm.

Hab.—Bromsgrove and Tardebigge.

Section II.—Onisci.

Family Oniscidae.

Body oval or oblong, with lateral plates more or less expanded. Eyes compound and well developed.

Genus Oniscus, Linn., 1767.

Body broad and depressed. Cephalon with well-defined lateral lobes. Eyes large, sublateral. Terminal joint of antennulae well developed. Flagellum of antennae 3-jointed.

O. asellus, Linn.

Oniscus asellus, Linn., Fauna suecica, 1746, vol. 4, p. 183.

Oniscus murarius, Cuvier, Mem. Cloportes terr., 1792, p. 22, plt. 26; Sars, Crust. Norw., 1898, vol. 2, p. 171, plt. 75.

This is one of the commonest species and practically found everywhere.

I fully agree with Sars (27) that the name *asellus* assigned to this species by Linnaeus should be rejected. Undoubtedly several

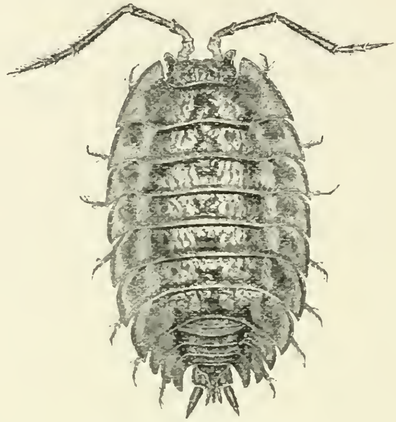

Fig. 3.—*Oniscus asellus*, L.

species were confounded under that name, whereas there is no doubt about Cuvier's determination.

Hab.—Plentiful over the whole of the Plateau.

Genus **Philoscia**, Latreille, 1804.

Body oval and slightly convex. Cephalon rounded in front, without projecting lateral lobes. Lateral plates of mesosome not prominent. Eyes well developed, lateral. Antennae slender, with 3-jointed flagellum.

P. muscorum (Scop.).

Oniscus muscorum, Scopoli, Entomol. Carnio., 1793, p. 415.
Philoscia marmorata, Brandt, Bull. Soc. Nat., Moscow, 1833, vol. 4, p. 183.
Philoscia muscorum, Bate and W., Hist. Brit. Crustac., 1868, vol. 1, p. 450; Sars, Crust. Norw., 1898, vol. 2, p. 173, plt. 76, fig. 1.

Might, at first sight, be confounded with *Ligidium hypnorum*, Cuvier, but is distinguished from that species by the shorter metasome, uropoda, and general colour. Length of adult 8.5 mm.

Hab.—Fairly common in both Warwickshire and Worcestershire.

Genus **Platyarthrus**, Brandt, 1833.

Body oval, depressed. Lateral plates of mesosome expanded and serrated. Eyes absent. Metasome broad. Antennae short and stout, flagellum single-jointed.

P. hoffmannseggii, Brandt.

Platyarthrus hoffmannseggii, Brandt, Bull. Soc. Nat., Moscow, 1833, vol. 6, p. 174, plt. 4, fig. 10; Sars, Crust. Norw., 1898, vol. 2, p. 175, plt. 76, fig. 2.

Fig. 4.—*Platyarthrus hoffmannseggii*, Brandt.

This species, which lives in ants' eggs, is easily distinguishable from any other British species, by its size, 3 mm., its pure white colour, flat body, stout antennae and the absence of any eyes.

Hab.—Near Redditch, Worcester.

Genus **Porcellio**, Latr., 1804.

Body oval, more or less depressed. Cephalon with well developed lateral lobes and projecting frontal lobe. Metasome not abruptly contracted. Eyes, usually well developed, subdorsal. Antennae slender with 2-jointed flagellum. Pleopoda with pseudo-tracheae.

P. scaber, Latr.

Porcellio scaber, Latreille, Hist. Nat. Crust., 1804, vol. 7, p. 45; Sars, Crust. Norw., 1898, vol. 2, p. 176, plt. 76.

Fig. 5.—*Porcellio scaber*, Latr.

This species is equally common as *Oniscus asellus*, Linn. The well-developed lateral plates of the body and the produced lobes of the head clearly separate it from any other members of the Genus. Length of adult 14 mm.

The variety *marmorata* I have once taken near Worcester, also a deep reddish-brown form, which I propose to name var. *rufescens*, nov.

Hab.—Common all over the Plateau.

P. pictus, Brandt and Ratz.

Porcellio pictus, Brandt and Ratzeburg, Medizin. Zool., 1833, p. 78, plt. 12, fig. 5; Sars, Crust. Norw., 1898, vol. 2, p. 177, plt. 78, fig. 1.

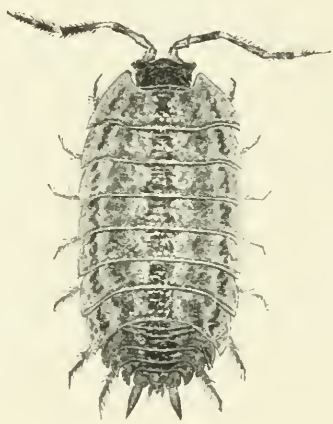

Fig. 6.—*Porcellio pictus*, B. and R.

This handsome species may be readily recognized by the greatly depressed body, the broadly rounded frontal lobe, the slender antennae, and the peculiar colouring. Length of adult 14 mm.

Hab.—Fairly common on all parts of the Plateau.

P. dilatatus, Brandt.

Porcellio dilatatus, Brandt and Ratzeburg, Medizin. Zool., 1833, p. 78, plt. 12, fig. 6; Sars, Crust. Norw., 1898, vol. 2, p. 179, plt. 78, fig. 2.

The great breadth of this species at once distinguishes it from all others of the Genus, as does also the shape of the last segment of the metasome. Length of adult 14.5 mm.

Hab.—Botanical Gardens, Edgbaston.

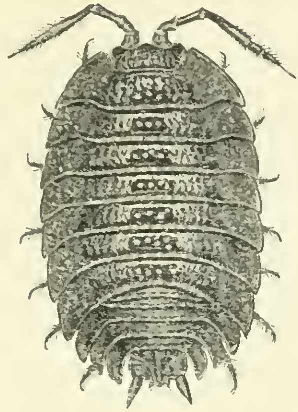

Fig. 7.—*Porcellio dilatatus*, Brandt.

P. rathkei, Brandt.

Porcellio rathkei, Brandt, Bull. Soc. Nat. Moscow, 1833, vol. 6, p. 177, fig. 10; Sars, Crust. Norw., 1898, vol. 2, p. 180, pl. 79, fig. 1.

The smooth, convex dorsal face of the body and the three longitudinal rows of whitish patches on the mesosome will generally serve to distinguish this species, but in colour it is exceedingly variable, more so than any other species I know of, differing markedly in the two sexes.

A striking variation I have met with I take to be the variety described by Schnitzler (32) as *P. striatus*. Length of adult 12 mm.

Hab.—Shenstone, Stafford.

P. laevis, Latr.

Porcellio laevis, Latreille, Hist. Nat. Crust., 1804, vol. 7, p. 46; Sars, Crust. Norw., 1898, vol. 2, p. 181, plt. 79, fig. 2.

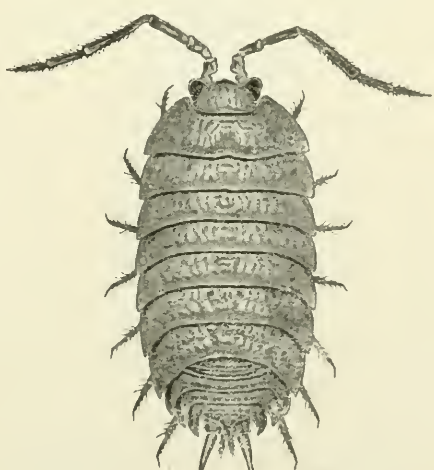

Fig. 8.—*Porcellio laevis*, Latr.

The broad, smooth body, the form of the lateral plates of the mesosome, and the greatly produced uropoda separates this species from its allies. Like the preceding species it is very variable in colour. Length of adult 15 mm.

Hab.—Claverdon, Warwickshire; Shenstone, Stafford.

M. cingendus, Kinahan.

Porcellio cingendus, Kinahan, Nat. Hist. Rev., 1857, vol. 4, p. 279, plt. 19, figs. 1468-9.

The distinct steel-blue colour, with scattered red and yellow blotches, and the prominent raised line across each segment of the mesosome serve to distinguish this species from any others. Length of adult 6 mm.

Hab.—Garden at Hatton, Warwickshire.

Genus **Cylisticus,** Schnitzler, 1853.

Body long, strongly convex and capable of rolling up into a ball. Lateral plates of 1st segment of mesosome large. Cephalon with distinct lateral lobes, but very small or obsolete medium lobe. Antenna with 2-jointed flagellum.

C. convexus (De Geer).

Oniscus convexus, De Geer, Mem. a l'hist. insectes, 1778, vol. 7, p. 533, plt. 35, fig. 11.

Cylisticus convexus, Sars, Crust. Norw., 1898, vol. 2, p. 186, pl. 81.

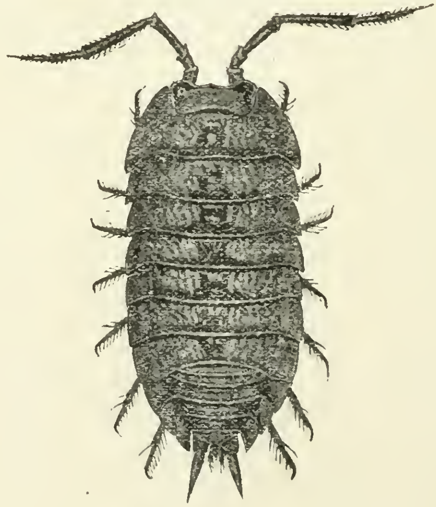

Fig. 9.—*Cylisticus convexus*, De Geer.

Easily recognized by the strongly convexed body and its power of rolling itself into a ball, as in the genus *Armadillidium*, but the slender antennae and structure of the uropoda at once separate it from that genus. Length of adult 12 mm.

Hab.—Claverdon, Lapworth, Henley-in-Arden, Warwickshire.

P. ratzeburgii, Brandt.

Porcellio ratzeburgii, Brandt, Bull. Soc. Nat. Moscow, 1833, vol. 6, p. 178; Sars, Crust. Norw., 1898, vol. 2, p. 182, plt. 80, fig. 1.

This species was first recorded as British by Webb (26) in 1898. It is allied to *P. rathkei*, Brandt, but may be distinguished from that species by the very prominent cephalic lobes; further, the distal joint of the flagellum is longer than that in *P. rathkei*. Length of adult 11 mm.

Hab.—Near Kings Norton.

Genus Metoponorthus, Budde Lund, 1879.

= *Porcellionides*, Miers, 1876.

Body oblong, sub-depressed, integument thin. Lateral lobes of cephalon small, frontal lobe absent. Flagellum of antenna 2-jointed.

M. pruinosus (Brandt).

Porcellio pruinosus, Brandt, Bull. Soc. Nat. Moscow, 1833, vol. 6, p. 181.
Metoponorthus pruinosus, Sars, Crust. Norw., 1898, vol. 2, p. 184, plt. 80, fig. 2.

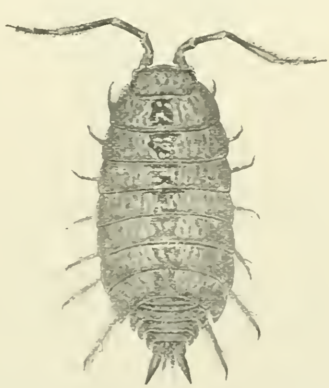

Fig. 10.—*Metoponorthus pruinosus*, Brandt.

This species may be recognized by its oblong, flattened body and the 2-jointed flagellum. Webb (37) mentions that "undamaged specimens are of a beautiful bluish-grey colour, owing to a 'bloom' which is easily brushed off, revealing it." Length of adult 9 mm.

Hab.—Sutton Coldfield.

Fam. **Armadillidiidae**.

Body convex, contractile into a ball. Cephalon with lateral lobes. Uropoda short, not extending beyond the limits of the last segment.

Genus **Armadillidium,** Brandt, 1830.

Body oblong or elliptical, strongly convex. Lateral plates of 1st segment of mesosome large. Flagellum of antenna 2-jointed.

A. vulgare (Latr.).

Armadillo vulgare, Latreille, Hist. Nat. Crust., 1804, vol. 7, p. 48.
Armadillidium vulgare, Sars, Crust. Norw., 1898, vol. 2, p. 189, plt. 82.

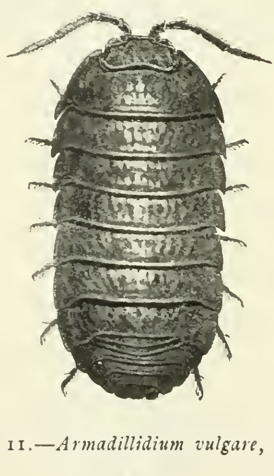

Fig. 11.—*Armadillidium vulgare*, Latr.

This is the common pill woodlouse. The form of the head and the last segment of metasome separate from all other members of the genus. Length of adult 15 mm.

Hab.—Fairly common in various parts of the Plateau. Some few years ago it was unusually plentiful near Warwick.

A. nasatum, Budde-Lund.

Armadillidium nasatum, Budde-Lund, Crustac. Isop. Terr., 1885, p. 51.

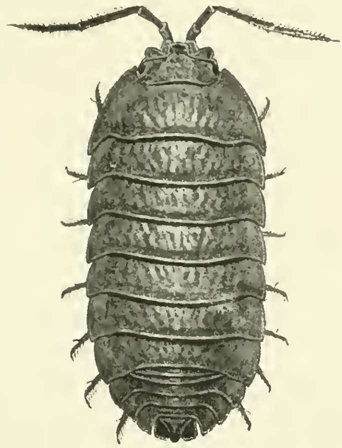

Fig. 12.—*Armadillidium nasatum*, Budde-Lund.

The body is densely and finely punctated. Colour brownish-grey, with 3-5 pale spots on each segment. Length of adult 15 mm.

Hab.—Claverdon, Warwickshire.

A. pulchellum (Zencker).

Oniscus pulchellus, Zencker, Panzer. Deutsch. Insekten, 1799, Heft 62.
Armadillidium pulchellum, Brandt, Bull. Soc. Nat. Moscow, 1833, vol. 6, p. 188.

This small species was fairly common some years ago in Warwickshire, but I have not met with it now for some time past. Length of adult 5 mm.

Hab.—Claverdon, Knowle, and Solihull, Warwickshire.

A. depressum, Brandt.

Armadillidium depressum, Brandt, Bull. Soc. Nat. Moscow, 1833, vol. 6, p. 82, plt. 12, figs. 4-6D.

The somewhat flattened body, the well developed first thoracic segment, the long antennae, together with the slaty-grey colour with yellowish markings, will serve to identify this species. Length of adult 15 mm.

Hab.—Knowle.

VI.—BIBLIOGRAPHY.

1. **Bagnall, R. S.**—On *Armadillidium album*, Dollfus, a rare woodlouse new to the Fauna of Great Britain. Zoologist, 1908, pp. 152-154.

2. **Bagnall, R. S.**—On *Philoscia patiencei*, sp. n., a new Terrestrial Isopod. Ann. Mag. Nat. Hist., 1908, ser. 8, vol. i, pp. 428-431, plt. xviii.

3. **Bagnall, R. S.**—Records of Some Irish Woodlice. Irish Nat., 1908, pp. 259, 260.

4. **Bagnall, R. S.**—On some Terrestrial Isopods from the Glasnevin Botanic Gardens, Dublin. Irish Nat., 1909, pp. 42-44.

5. **Bate, C. Spence and J. O. Westwood.**—A History of the British Sessile-eyed Crustacea. London: 1868.

6. **Brandt, J. F.**—Conspectus Monographie Crustaceorum Oniscodorum Latreillei. Bull. Soc. Nat., Moscow, 1833, vol. vi, pp. 171-193.

7. **Brandt, J. F. and J. T. C. Ratzeburg.**—Medizinische Zoologie. Berlin: 1830-34, vol. ii.

8. **Budde-Lund, G.**—Danmarks Isopode Landkrebsdyr. Naturhist. Tidsskrift., 1870, vol. vii, pp. 217-245.

9. **Budde-Lund, G.**—Prospectus generum specierumque Crustaceorum Isopodum terrestrium. Copenhagen, 1879.

10. **Budde-Lund, G.**—Crustacea Isopoda Terrestria. Hauniae, 1885.

11. **DeGeer, C.**—Memoires pour server a l'histoire des insectes. Stockholm, 1778, vol. vii.

12. **Dollfus, A.**—Catalogue raisonne des Isopodes terrestres de l'Espagne. Ann. Soc Espan. Hist. Nat., 1892, vol. xxi, pp. 161-190.

13. **Foster, N. H.**—*Trichoniscus pygmaeus*, Sars, a woodlouse new to Ireland. Irish Nat., 1908, p. 56.

14. **Foster, N. H.**—*Armadillidium pictum*, Brandt. An Addition to the Britannic Fauna. Ibid , 1908, pp. 135, 136, plt. 6.

15. **Foster, N. H.**—*Trichoniscus stebbingi* in Down and Antrim. Ibid., 1911, p. 95.

16. **Foster, N. H.**—On Two Exotic Species of Woodlice found in Ireland. Ibid., 1911, pp. 154-156.

17. **Kinahan, J. R.**—Analysis of certain genera of Terrestrial Isopoda. Nat. Hist. Rev., 1857, vol. iv.

18. **Kinahan, J. R.**—On the Genera *Philoscia*, *Itea* and *Philougria*. Nat. Hist. Rev., 1858, vol. v.

19. **Koch, C. L.**—Deutschlands Crustaceen, Myriapoden and Arachniden. Regensburg, 1835-44.

20. **Latreille, P. A.**—Histoire Naturelle des Crustaces et des Insectes. Paris, 1804, vol. vii.

21. **Norman, A. M.**—Note on the discovery of *Ligidium agile*, Persoon (= *Zia saundersii*, Stebbing), in Great Britain. Ann. Mag. Nat. Hist., 1873, Ser. 4, vol. xi, p. 419.

22. **Norman, A. M.**—British Land Isopoda. Ibid., 1899, Ser. 7, vol. iii, pp. 71-78, pl. vi.

23. **Norman, A. M.**—British Land Isopoda—Supplement. Ibid., 1903, Ser. 7, vol. xi, pp. 369-373.

24. **Norman, A. M. and C. S. Brady.**—British Land Isopoda—Second Supplement. Ibid., 1904, Ser. 7, vol. xiv, pp. 449, 450.

25. **Pack-Beresford, D. R. and N. H. Foster.**—On the Distribution of Woodlice in Ireland as known at the end of 1908. Irish Nat., 1909, pp. 92, 93.

26. **Richardson, Harriet.**—Monograph on the Isopods of North America. Proc. U.S. Nat. Mus., Bull. No. 54, 1905.

27. **Sars, G. O.**—An Account of the Crustacea of Norway. 1896-99, vol. ii, pp. 153-192, plts. 70-83.

28. **Scharff, R. F.**—The Irish Woodlice. Irish Nat., 1894, vol. iii, pp. 4-7 and 25-29, plt. ii.

29. **Scharff, R. F.**—The Woodlice of Co. Carlow. Ibid., 1895, p. 319.

30. **Scharff, R. F.**—*Armadillidium pulchellum*, Brandt. A Woodlouse new to the British Isles. Ibid., 1901, pp. 109, 110, 1 fig.

31. **Scharff, R. F.**—*Metoponorthus melanurus*, a Species of Woodlouse new to Ireland. Ibid., 1910, p. 92.

32. **Schnitzler, H. J.**—De Oniscineis agri Bonnensis. Cologne, 1853.

33. **Stebbing, T. R. R.**—On a Crustacean of the Genus *Zia*. Ann. Mag. Nat. Hist., 1873, Ser. 4, vol. xi.

34. **Stebbing, T. R. R.**—The Victoria County History of Essex. Crustacea, pp. 27, 28, 1903.

35. **Stephens, N. E.**—Some Terrestria Isopoda found in Cos. Dublin and Wicklow during 1911. Irish Nat., 1911, pp. 195, 196.

36. **Webb, W. M.**—The occurrence in Essex of a species of Woodlouse (Isopoda) new to Britain (*Porcellio ratzeburgii*, Brandt). Essex Nat., 1899, vol. xi, p. 127.

37. **Webb, W. M.**—Notes on Woodlice. Sci. Goss., 1900, vol. vi, n.s., pp. 295, 296.

38. **Webb, W. M. and C. Sillem.**—The British Woodlice, being a Monograph of the Terrestrial Isopod Crustacea occurring in the British Isles. London: 1906. Pp. x + 54 and 25 plates.

Contains excellent figures of all the species and a full bibliography.

A BRIEF REVIEW OF THE SCIENTIFIC WORK DONE ON THE CEYLON PEARL BANKS SINCE THE YEAR 1902.

By

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I HAVE thought it desirable to review briefly the scientific work done by myself, Prof. Herdman, and Mr. Hornell, on the Ceylon Pearl Banks during the last ten years, as these results have recently been the subject of adverse criticism by Dr. Lyster Jameson. I propose here replying to his remarks in so far as they touch on my own work.

In the following two papers Dr. Jameson attempts to set at naught the work of the last ten years:—

I. "An examination of the causes which have led to the failure of the Biological Work recently undertaken on the Ceylon Pearl Fisheries." *Journal of Economic Biology*, Feb., 1912, Vol. iii, Part I.

II. "Studies on Pearl Oysters and Pearls." (1) Structure of the shell and pearls of the Ceylon Pearl Oyster (*Margaritefera vulgaris*, Schumacher), with an examination of the Cestode theory of Pearl Production. *Proceedings of the Zoological Society*, London, June, 1912.

The Pearl Banks are situated on the west coast of Ceylon. From the shore the sea gradually deepens to the west, to a depth of from ten to fifteen fathoms, and then suddenly and precipitously deepens to several hundred fathoms. The distance of this line of overfall from the shore varies greatly in different places. To the south the line of overfall may be only half a mile. Towards the north, however, it is distant eighteen miles. It is only on this shallow water plateau that oysters are found. Its area is not less than 1,200 square miles. The bottom is mostly sand, and oysters cannot live there. A fringing reef runs parallel to the beach. Oysters rarely live, and certainly never flourish, in the shallow water inshore. The rocky area or "paar" consists of isolated patches, and, in all, covers perhaps 150 square miles. It is on this area alone that oysters can live. The oysters attach themselves to such rock by means of a byssus or beard, like a mussel, and pass their sedentary lives in this way.

[JOURN. ECON. BIOL., February, 1913, vol. viii, No. 1.]

The uncertain and erratic nature of the Fisheries has been recognised for many centuries. Periods of barrenness succeeded years of plenty, and the cause remained unknown. Prior to 1902 only a few "paars" were ever inspected, and the greater part of the rocky area remained unexamined. Instances are on record in which fisheries have been held on "paars" discovered by the merest accident. Beds of oysters were sometimes found two, four, and five years' old, whereas if inspections had been carried out systematically and thoroughly, they could not have remained undiscovered for more than six months. The records of barren years on the Ceylon Banks are, therefore, unreliable; they merely represent barren years on certain particular parts of the potential area.

In 1902, Prof. Herdman was deputed by the Royal Society, on behalf of the Colonial Government, to investigate the various problems relating to the pearl banks, and especially the erratic nature of the fisheries. His five voluminous Reports are well known. After Prof. Herdman had finished his investigations, Mr. Hornell, who had acted as Assistant to Prof. Herdman during his stay in Ceylon, was left to continue the work on the spot. The Ceylon Marine Biological Laboratory was thus founded. Its first headquarters were at Galle, but were subsequently changed to Colombo, although the great bulk of the work was done at sea, on board the barque Rangasamee Porawee. In 1903, Mr. Hornell was appointed Marine Biologist to the Ceylon Government. During this appointment two Reports were issued, viz., Parts I and II, *Reports from the Ceylon Marine Biological Laboratory*. In 1905 the northern area of the Pearl Banks plateau was leased out by Government to a London Syndicate. Mr. Hornell left the service of Government and took up duties as Manager of this Company. The Ceylon Marine Biological Laboratory thus passed from the hands of Government, and became controlled and carried on entirely by the Company. In 1906 I came out to Ceylon as Scientific Assistant to the Company. Early in 1908 Mr. Hornell relinquished his appointment, and I assumed full executive duties. Later in the year Lieutenant J. C. Kerkham, R.N.R., was appointed Superintendent of Fisheries, and the scientific work devolved on me. This arrangement continued up to the end of 1911, and it was during this time that I published Parts III, IV, V, and VI of the *Ceylon Marine Biological Reports*. The Ceylon Company of Pearl Fisheries ceased to exist about March, 1912.

My last report, published in January, 1912, evidently had not reached Dr. Jameson when he published his criticisms, for in my Report I deal with many points raised by him. The financial side

of the Company's affairs did not concern me, but as the failure of the Company has resulted in a complete cessation of scientific work, and as it seems to be understood that scientific investigation should have counteracted, if not entirely annulled, the efforts of unwise speculation, the following points may be noted:—The capital of the Company was Rs. 2,475,000 (or £165,000). The yearly rental was Rs. 310,000. In addition to this, a sum of from Rs. 50,000 to Rs. 150,000 had to be spent yearly on certain lines of "Pearl oyster culture" laid down on the lease. The minimum yearly expenditure was not less than Rs. 450,000 (or £30,000). Assuming the average profit on a normal fishery to be £60,000, it follows that, in order to make the enterprise successful, a good fishery must take place every two years.

In the history of the Banks there are instances in which blanks of 2, 12, 28, and even more years have occurred. It is conceivable that in certain quarters it was anticipated that with the advent of scientific enquiry, methods would speedily be evolved whereby fisheries would take place with consistant regularity, and Dr. Jameson apparently shared this opinion. He writes as follows:— "Mr. Southwell's writings betray a certain air of the detachment from the side of the enterprise which alone matters to the investing public"; and a little further on he states that "Mr. Southwell's more strictly biological activities were in great measure dissipated over purely faunistic work, such as the description of new species of crabs and tapeworms. . . . A little intelligent directive advice, occasional consultation with outside experts . . . might well have given this Company a quite different history. . . . With regard to the scientific causes I cannot help feeling that throughout these Ceylon investigations the weak point has been the failure to sufficiently sharply distinguish between those phenomena which have a special and intimate relation to that particular economic problem, the solution of which means so much to the colony, viz., the acquisition of some control over the natural supply of pearl oysters and pearls, and those phenomena whose relations to the central problem are of a more general nature."

There is, I believe, little reason to doubt that Dr. Jameson is not alone in his view that the failure of the Company is to be attributed to the inefficiency of the scientific work carried out on the banks, but it is regrettable to find these opinions so strongly emphasized by one with a considerable amount of scientific work to his credit. That part of Dr. Jameson's work, however, which deals with oysters, refers, for the most part, to variations met with in the shell

in different parts of the world, the number and variety of teeth by which the valves of the shell are interlocked, and the minute structure of the prismatic and horny layers. His researches have also been devoted to the origin of the pearl sac and a variety of other details connected therewith, but he has no personal experience of the Ceylon banks, or of the special problems involved. It is to this fact that his failure to realise the essential features of the case may be attributed. Coming from a scientific man, the statement that activities were in great measure dissipated over crabs and tapeworms is somewhat unexpected. I may state, however, that these short papers, six in number, were prepared during long sojourns out at sea, covering $5\frac{1}{2}$ years, when the only relaxation possible was change in the nature of the work in hand.

Dr. Jameson's criticism is entirely of a destructive nature; he is unable to suggest any new lines of investigation or projects calculated to extend the economic results.

The only suggestion he makes is that the larvae in the globular cysts in the oyster are species of *Tylocephalum* and not of *Tetrarhynchus*. The point is purely technical. Dr. Jameson himself does not here distinguish between those phenomena which have a special relation to economic results and those phenomena which are of a general nature. The economic aspect of pearl fishing would not be altered the slightest even if the larvae found in the oysters happened to be those of a frog and not of a tapeworm.

The biological work on the Ceylon Banks has, I submit, been economic in nature, and, in order to show in what ways the work was economic, I will now review the problems which presented themselves and the line of investigation taken.

The conclusion arrived at by Prof. Herdman after his visit to Ceylon was, briefly, that the intermittance of fisheries on the Pearl Banks was due largely to the following causes :—

I. Shifting of sand by currents and storms which overwhelm beds of oysters.

II. The ravages of predatory fish.

III. Overfishing.

IV. Disease.

V. Overcrowding.

These conclusions may be dealt with *seriatim*.

I. As far as I know, no remedy was proposed to obviate the silting over of beds of oysters. I have shown in my last Report that during my period of office no evidence was found which supported Herdman's conclusion.

Strong surface currents were often experienced, but no bottom currents were present. Descents were regularly made in a diving dress. A bottom current sufficiently strong to sweep away, and entirely annihilate, whole beds of oysters must be strong indeed, and could not fail to be noticed.

II. With reference to the ravages of predatory fish I have shown that during November 1908, a bed of 400,000,000 spat, covering 964 acres, was entirely annihilated by voracious fish on the Periya Paar Karia. Dr. Jameson states that I treated this matter to some extent as a new discovery, and points out that reference was made to this fact by Sir William Twynam in 1900. In the very paper which he criticises I stated that "the fact then that certain fish feed on oysters is well vouched for and has been known for many years." The object of the notes which I then published was to supply details of loss from this cause, and I have, I believe, satisfactorily proved that on this particular bank 84 per cent. of the oysters were destroyed by predatory fish.

III. As regards overfishing, there can be no doubt that this has been carried on ever since pearl oysters became economic products, and that it has contributed largely to the present run of barren years.

IV. Of disease amongst oysters I saw none. Occasionally oysters were found of a golden yellow colour, but these were in good condition. A few oysters were found on several occasions growing in shallow water and on reefs. These were always thin and emaciated, a condition one expects under the circumstances.

V. Whenever a spat-fall occurs, it is always and invariably overcrowded. Prof. Herdman's proposal to transplant these oysters was sound. Dr. Jameson complains that there is no published evidence to satisfy biologists (or the Ceylon Government or shareholders) that transplanting has been given a sufficient trial. This is indeed the case. During my period of office there were no oysters or spat to transplant. Those transplanted by my predecessors all died. In my report I suggested a *possible* cause of this loss. Dr. Jameson states that the question never seems to have been followed up, but as these oysters had been dead a year when I assumed office, and as their shells could not be found, it was impossible to do more than speculate on the cause of the disaster. Such, in mere outline, were the results obtained in following up Prof. Herdman's conclusion. I was convinced, however, years ago, that although overfishing, overcrowding, the ravages of predatory fish and the like, all tended to deplete the banks, and occasionally to produce barren years, they were in themselves insufficient to account for the long unproductive

periods which have occurred. The continuity of the fisheries can, I think, be considered as the foremost economic question connected with the pearl fishing in Ceylon. The results of my own investigation into the cause of these barren years were published in January, 1912. As Dr. Jameson does not deal with this report, and has not since discussed the results set forth therein, I will here summarise the conclusions arrived at.

There has long been a belief that the Ceylon Pearl Banks were occasionally replenished with spat derived from elsewhere, probably from Southern India. Without this assumption it was impossible to account for immense numbers of spat found on the Banks from time to time, when no adult oysters seemed to occur.

I have already pointed out that it is certain that during the last century oysters *did* occur on certain parts of the Banks and were never found. In such cases it is reasonable to assume that these oysters provided the apparently miraculous spat-fall. In order to ascertain whether or not spat could be brought across from India by the agency of surface currents, a careful and comprehensive survey into these agencies was made.

The Pearl Banks lie in a cul-de-sac, the only exit being the narrow and shallow channel forming Paumban Pass. Pearl oysters occur along the south-east corner of India, south of Tuticorin. It is only rarely that fisheries have been held there. The reason for this will appear later. The south-west monsoon usually commences in May, and dies away early in October. It is at its height during July and August, and it is during these months that the Pearl oysters spawn. The larvae are pelagic, and live on the surface of the ocean for at least five to seven days, when, having acquired a shell, they drop to the bottom in the position in which they happen to be in at the time. The distribution of the Pearl oyster larvae, therefore depends entirely on the surface currents prevalent at the time. By the aid of drift bottles, liberated during three successive seasons, in various chosen places, during the height of the monsoon, the following facts were established :—

During the south-west monsoon there is an oceanic current running from the west towards the east. In a weak monsoon this current does not touch Ceylon, but sweeps to the south and west. During a strong monsoon, however, owing purely to the effect of the monsoon, this volume of water becomes pushed up northwards, into the Gulf.

The direction of the surface currents in the Gulf depend entirely on the strength of the monsoon. If the monsoon is weak the surface

currents, as a result of the monsoon, both on the Ceylon and India side, run to the north, and any spat liberated at such a time would drift north, pass through Paumban Pass and be lost. If the monsoon is prolonged and strong, the exit at Paumban Pass becomes insufficient to relieve the pressure in the Bay and consequently the water rises above the normal level. In that case the exit at Paumban Pass acts merely in relieving the pressure, and no currents are produced until the head of water had been relieved. During this time, viz., when the monsoon is strong and prolonged, we have seen that the oceanic current becomes, as it were, pushed up into the Gulf. It sweeps round the Gulf in the form of an arc of a circle, running northerly along the south-east coast of India, and reaches Ceylon usually about Tallaivillu Point. The stronger the monsoon the further north does the current penetrate, and the conditions are then present for spat being carried from Southern India on to the Ceylon Pearl Banks. The rate of the current is .5 knot per hour. The distance from Tuticorin to the Ceylon Banks is 85 miles. Taking seven days as the maximum time occupied by the pelagic stage of the oyster, a *continuous strong monsoon during this period would place exotic spat on the Ceylon Pearl Banks.*

At the same time it would carry away any local spat, and also any spat liberated on those banks which were not under lease. Whether the monsoon is strong or weak, the spat produced on both the Tuticorin Banks and on that portion of the Ceylon Pearl Banks not under lease, is invariably lost. The arena which was under lease will receive spat from Tuticorin, if oysters are present there, only when the monsoon is strong.

It will be obvious that it must frequently happen that in a fairly strong monsoon the larvae fail to reach the Pearl Bank plateau we have described, and, dropping into deep water, are lost. It is remarkable how the productivities of the paar areas named, viz., Southern Indian Banks, the Ceylon Banks which were under lease, and the Ceylon Banks which were *not* under lease, coincide with the evidence afforded by currents.

The conclusions I have arrived at are not strained, and the evidence afforded by the currents is clear and precise.

In the light of the preceding results, we may refer here to Dr. Jameson's indictment that the biological work failed because it did not acquire some control over the natural supply of Pearl oysters. Can Dr. Jameson suggest a means of controlling the wind and the waves, and the uncertain currents of the ocean? He states that the results of the drift bottle experiments appear to him to be scarcely

capable of economic application until the duration of the free swimming stage of the Pearl oyster is accurately known. Prof. Herdman states that the larval stage occupies about seven days. My own results, which I did not publish, gave a slightly shorter duration; probably the time occupied varies a little with the temperature and other conditions. The determination is sufficiently accurate for the purpose in hand. Had a multitude of experiments been carried out, and the period fixed with the greatest scientific accuracy, it could not possibly have affected the conclusions suggested in this paragraph.

We will now refer as briefly as possible to Dr. Jameson's more academic discussion of the "Cestode theory of Pearl formation." This subject pales in significance when compared with that of the natural supply of oysters, without which there could be neither shells nor pearls.

The facts relating to the cestode theory of pearl formation may be briefly stated as follows :—

Prof. Herdman found a number of almost microscopic globular bodies scattered about in the tissues of the Pearl oyster. These were of all sizes up to about 1 mm., and were determined to be larval stages of a tapeworm. Everyone agrees that these *are* larval cestodes —Dr. Jameson included. Other parasites found in the intestine (only) of the oyster were well advanced, and were easily recognised as belonging to the genus *Tetrarhynchus*. These two parasites were believed by Herdman to be different stages in the life-history of one species. Another parasite was found in *Balistes*, which, since *Balistes* eats oysters extensively, was supposed to be a further stage in the life-history of the same form. An adult worm was discovered in a Ray, *Aetobatis narinari*, which was believed to be the mature adult stage, and was named *Tetrarhynchus unionifactor*. Finally a microscopic larva was found in the tow-net, which was believed to be the embryonic form of the parasite in question. The decisions arrived at were somewhat indefinite.

Dr. Jameson has isolated various paragraphs from my reports and used them in a connection for which they were not meant, thereby distorting the whole situation in a discussion covering eighteen pages of his paper in the *Proceedings of the Zoological Society, London*. I cannot but regard this procedure as either a failure to comprehend the results arrived at, or a wilful attempt to pervert the issues.

I showed that it was impossible to accept the free swimming larval stage mentioned by Herdman as being the embryo of the Pearl

inducing worm, on the grounds that the larvae of a variety of cestodes have the same habit. I pointed out that, whilst the globular cysts in the oyster contained embryos whose cestode characters were ill-defined, the larger forms, found in the wall of the gut, were so far adult as to be capable of specific distinction. No stages between these two forms of larvae have been discovered. I further obtained adult and mature worms of *Tetrarhynchus unionifactor* from four species of Elasmobranch, thus showing that the final hosts were not confined to *Aetobatis narinari*, as had been supposed, and that the adult probably occurred in all Elasmobranchs which fed on oysters. Amongst Teleosts I found larval stages, only, of the same worm, and concluded that *Balistes* and other genera of Teleosts were merely collateral hosts to the larva, a result arrived at independently by Johnstone in England in the case of another species of the same genus.

The various sizes of globular cysts found in the oyster were shown to be due to the fact that the larger larvae multiplied endogenously. Finally, by feeding experiments, I was successful, on two separate occasions, in transmitting the adult cestode to an Elasmobranchs by feeding the latter on Pearl oysters containing the larva, the adult being obtained months later in the spiral valve of the fish.

Dr. Jameson admits there is very good reason to believe that in my feeding experiments I did actually transmit *Tetrarhynchus unionifactor* from the oyster to the Elasmobranch. He believes, however, that the mature worms from the Elasmobranch were derived from the young worm found encysted in the gut of the oyster, and not from the larva in the globular cysts. He further states that these latter cysts are of two (possibly three) species and sizes, and that they belong to the genus *Tylocephalum*. He founds two new species on larvae whose cestode characters are even at best but ill-defined. The larvae in question are of *all* sizes, and are not divisable into either two or three grades, and had his material not been, as he states, somewhat scanty, he could not have escaped the obvious probability that the larvae are all of the same species, and that the wide range of size is due to the endogenous multiplication taking place. If these larvae belong to the genus *Tylocephalum*, why was it that no species of this genus was obtained in the feeding experiments which were carried out? Dr. Jameson concludes that the adult of these globular cysts occurs in the ray *Aetobatis narinari*. There is not the slightest ground of support for this theory, and it is not easy to discover the utility of evolving theories to replace the practical results obtained on the spot.

The "activities dissipated over the description and examination of tapeworms," enable me to state positively that at least 99 per cent. of the representatives of the genus *Tylocephalum* on the Ceylon Pearl Banks are found in small species of *Trygon* which are incapable of eating oysters. Although I examined large rays almost daily over a period of 5½ years, I do not remember, and I have no record of ever having obtained, a single representative of the genus *Tylocephalum* from a large ray.

He points out that the larva contained in the globular cyst has more resemblance to the head of a *Tylocephalum* than to that of a *Tetrarhynchus*. The only possible way in which a determination of these larva can be made is by feeding experiments. This is a question which cannot be settled in the laboratory or the library. Dr. Jameson's determinations of this cyst are negatived by the facts, and his generic identification is entirely hypothetical. He objects to the name of *Tetrarhynchus unionifactor* being given to these larvae before their identity can be demonstrated more satisfactorily, and at the same times he gives them two new specific names.

The accepted theory regarding the formation of Pearls is that they are formed round an irritating substance, which might be a grain of sand, etc., but which is usually the dead remains of one of the cestode larvae found in the tissues of the oysters. Why the parasite died no one has offered even an opinion.

Dr. Jameson has examined 356 pearls from different localities, including a few from the Ceylon Banks, and he has been unable to discover any trace of a parasite in the centre of any pearls he examined. His results are therefore in direct opposition to those of Prof. Herdman, Mr. Hornell and myself.

Prof. Seurat recognised the remains of cestode larvae in pearls from New Caledonia, but Dr. Jameson, after examining the material, was unable to confirm Prof. Seurat's observations.

Dr. Jameson states that "as the Ceylon Cestode parasite measures roughly from 0.5 to 1 mm. in diameter, the nucleus of a Ceylon pearl, if composed of its calcified remains, should, if anything, be larger, rather than smaller, than that of a *Mytilus* pearl." But Dr. Jameson seems to be unaware that the young larva sometimes measures less than 0.5 mms., and that larvae ranging in size between .05 and .1 mm. can almost always be seen. The calcified remains of such a larva might escape Dr. Jameson's attention, as he is accustomed to seeing, and expected to find, calcified remains ten times the size.

Dr. Jameson's statement that a pearl sac does not occur round the

cysts of the larger larva is no new one, the observation was made long ago, and no one believes that such larvae ever became the nuclei of pearls. But it is highly probable that larvae, just born by a process of endogenous reproduction, may die, and that, owing to the irritation set up, a pearl sac may be formed before the parasite has acquired a cyst at all. Moreover, such an accident is likely to happen, and fully and naturally accounts for the connection between infection and pearl formation. It also accounts for the presence of the larvae as pearl nuclei, as no other theory does.

Dr. Jameson states that "if pearls . . . are of parasitic origin . . . the immediate cause of the pearl is not mechanical irritation caused by the body of the parasite, but rather the toxic properties of its secretions . . . consequently the "cause" of the pearl is not to be looked for in the nucleus . . . but rather in the tissues of the oyster."

In a similar way one might argue that should one have the misfortune to receive a "black eye" through being hit with a cricket ball, the cause of the "black eye" is not the cricket ball, but is due to the tissues surrounding the eye.

During my period of office I examined large numbers of cyst pearls collected on the spot. Their number is well over 1,200. I have often found remains of a cestode larva inside such pearls. Not invariably, but frequently. I have never published the results. The reports which I have published from time to time represent, as I stated therein, but a fraction of the work which has been done. It has been known for years that the nucleus of cyst pearls was not always of cestode origin. If further evidence were needed that the nucleus of a cyst pearl is usually the larva of the parasite in question, it will be found in the firmly established fact that the pearl yield bears an intimate relation to the degree of infection. This weighty fact is dismissed by Dr. Jameson as being explanable on the assumption that the conditions which are favourable to cestode infection are also favourable to pearl formation. Passing by the assumption portion of this statement, Dr. Jameson offers no suggestion as to what the conditions are, or might be, which would, or might, favour pearl formation as well as cestode infection.

To other points raised by Dr. Jameson I need only refer in passing. The proposal to introduce oysters from elsewhere had been considered for over two years, and the idea was eventually abandoned as being entirely impracticable. The subject is dealt with in Part VI of my reports.

Dr. Jameson appears to think that the best advantage was not

made of the few oysters present on the Kondatchi paar. There were, in all, perhaps a good cart-load of these oysters. They represented the very last, and exceedingly scanty, supply. All were very thin and emaciated, and were dying rapidly. They died *more rapidly still* when transplanted elsewhere.

With reference to the hatchery tank at Marichchukadde, Dr. Jameson confesses himself amazed, but he thinks there is "considerable excuse for an officer like Mr. Southwell, cut off from access to literature . . . being unfamiliar . . . with what has been tried elsewhere."

He will find no details regarding these tanks in any of my published reports, for the simple reason that the whole concern was purely an experiment. An outline of this experiment was only placed before the Company in order to obtain necessary funds for its prosecution. Some spat was actually obtained. Similar methods of pond culture are carried on extensively in Norway, and in that country have proved a commercial success. Less successful results have been obtained in Ireland, where these operations have been practised during the last ten years.[1] Whether these operations could have been carried on to a greater degree or not in Ceylon had more brood oysters been available, no one can say. The matter was not a proposal, but an experiment, and in a very small way, a successful one. That an experiment which had for its object the acquisition of some control over the natural supply of Pearl oyster should have been so severely denounced by Dr. Jameson is surprising, as the lack of attempt to acquire such control is the main complaint in his paper.

We may now summarise in a general way the points dealt with in the foregoing paper :—

I. The failure of the Company was due to the fact that sufficient capital was not to hand to tide over the barren years which have always formed the outstanding feature of the Ceylon Banks. Such an unproductive period commenced almost immediately after the Company obtained the lease, and necessitated their liquidation before scientific enquiry had even had time to fully ascertain the cause, much less provide a remedy.

II. The scientific work done up to date has conclusively shown that natural supplies of pearl oysters are brought to the Ceylon Banks, from the south-east coast of India, by the agency of surface currents, and that this can only take place during very strong and prolonged south-west monsoon.

[1] Fisheries, Ireland, Sci. Invest. Gar. 1901 (1903), pp. 77-103.

III. Dr. Jameson's statement that the larvae contained in the globular cysts belong to the genus *Tylocephalum*, and are of two (possibly three) species, is entirely negatived by the facts. No species of the genus *Tylocephalum* were obtained during the breeding experiments, whilst species of the genus *Tetrarhynchus* were obtained in numbers. Moreover, the occurrence of species of the genus *Tylocephalum* in oyster-eating fish is extremely rare. The larvae within the globular cysts are of all sizes between .05 mm. and about 1 mm. This variation is the result of a process of endogenous reproduction which is continually going on.

IV. As Dr. Jameson objects to the name of *Tetrarhynchus unionifactor* being given to the larvae before their identity with the adult can be demonstrated, his own identification consequently cannot stand, for the same reason.

V. That as Dr. Jameson had apparently examined only a small number of undoubted Ceylon cyst pearls, his results, which are in direct contradiction to those obtained by Herdman, Hornell, Seurat and myself, will not meet with general acceptance. The present writer has repeatedly found a larva similar to that found in the globular cyst forming the nucleus of a Ceylon cyst pearl.

VI. When a larval cestode occurs as the nucleus of a pearl, it is a minute specimen, probably just born by a process of endogenous reproduction, and does not measure more than 1 mm., and frequently less, the larva being enclosed in a pearl sac before an external cyst is formed round it. As Dr. Jameson is accustomed to seeing larval *Trematodes* as nuclei in *Mytilus* pearls, often measuring .5 mm., and, according to his own statement, expects to find nuclei in Ceylon pearls of this size, or even larger, it is possible that such a minute larva as that of *Tetrarhynchus unionifactor* may have escaped his observation.

VII. Even were all Dr. Jameson's criticisms justified by the facts, they would not assist us in obtaining control over the supply of Pearl oysters.

REVIEWS.

Boulger, G. S.—Plant Geography. Pp. viii + 136, 16 figs. London: J. M. Dent and Sons, Ltd. 1912. Price, 1s. net.

To write a work along the lines chosen by Professor Boulger demands not merely an acquaintance with bare facts regarding the floras and vegetation of parts of the world, but also a considerable and accurate knowledge of the physiology and oecology of plants, geology and palaeo phytology, climatology and meteorology. These demands have not been satisfied in this little primer, in which there are all too numerous errors as to facts relating to various branches of the subject and as to terminology. This disappointing booklet does not promise well for the " more comprehensive work " which the Author " hopes soon to issue " on the same subject.

P. G.

Bruck, W. F.—Plant Diseases. Trans. by J. R. Ainsworth-Davis. Pp. 152, 1 plt. and 45 figs. London: Blackie and Son, Ltd., 1912. Price, 2s. net.

Professor Davis has translated or edited quite a large series of works on general biology, but it is unfortunate that the present little volume should have been included. Plant pathology is a highly technical subject, and requires—even for purposes of editing—an intimate acquaintance with the life-history, classification, etc., of numerous organisms. Further, there are many better works than that of Dr. Bruck's for the British student.

Unfortunately many of the species mentioned are not British, and quite a number of errors seriously detract from the value of the book, amongst these we may mention: p. 54 *Limax* should be *Agriolimax*; the scientific name of the fungus causing Yellow Wart Disease is inaccurate; p. 71 the Beet and Mangold Fly of Great Britain is not *Anthomyia conformis*, Fall., but *Pegomyia betae,* Curtis; in the same manner our Beet Carrion Beetle is not *Silpha atrata*. The account of the Woolly Aphis, p. 95, is most inaccurate and misleading.

It is to be regretted that such a work has been added to the literature in English on Economic Biology.

Daniels, C. W.—Tropical Medicine and Hygiene. Pt. III. Pp. viii + 250 and 15 figs. London: John Bale, Sons and Danielsson, Ltd. 1912. Price, 7s. 6d., net.

The present and concluding part treats of those diseases due to bacteria and other vegetable parasites, to dietetic errors and of unknown causation.

In view of Dr. Sambon's work the chapter on Pellagra seems somewhat out of date, and too much importance attached to the maize theory.

An Appendix gives a useful synopsis of the Fleas, and there is a good index.

The three parts form an extremely useful compendium upon a most important subject.

Fabre, J. H.—The Life of the Spider. Pp. xxxix + 378. London: Hodder and Stoughton. 1912. Price, 6s. net.

The fairy land of science has seldom been better portrayed than in the work before us. "The spider," the author states, "has a bad name: to most of us she represents an odious, noxious animal, which everyone hastens to crush under foot," but whatever opinion we may hold of the living organism, the account of the industry and habits of the various species here treated of form a most entrancing story. The minuteness with which everything is described gives us an insight into a chapter on animal psychology, which has certainly never been more carefully set down, and justly entitles the author to the title of "The Insect's Homer," bestowed upon him by Maeterlinck, in a characteristic preface.

Gemmill, J. F.—The Teratology of Fishes. Pp. xvii + 74, plts. i-xxvi and 6 figs. Glasgow: James Maclehose and Sons, 1912. Price, 15s. net.

Dr. Gemmill has brought together in this handsome volume a wealth of material of interest to the embryologist, morphologist and teratologist.

The main body of the work deals with abnormalities occurring in the trout and salmon. After a brief introduction and a very full bibliography, the author deals with the double monstrosity, their occurrence, records, and general outline, classification, causation, the development and early growth in fishes, and in vertebrates generally. The anatomy of double monstrosities is dealt with in great detail and illustrated by numerous excellent figures.

Other chapters deal with the triple monstrosity, cyclopia, and minor abnormalities, such as hermaphroditsm, those affecting the skull, vertebral column, fins, colouration, etc. There are three detailed indices and a summary of the contents of the twenty-six plates.

The work merits a distinct and important place in modern biological literature.

Hiesemann, M.—How to Attract and Protect Wild Birds. Trans. by Emma S. Buchheim. 3rd ed. Pp. 100, 14 figs. London: Witherby and Co., 1912. Price, 1s. 6d. net.

We welcome a third edition of this interesting little work, which deals in a practical manner with what is known as the Berlepsh System.

Whilst everyone would wish to see our beneficial birds protected, we very much doubt the wisdom of breeding, as stated on p. 24, greenfinches, blackbirds, chaffinches and starlings, and we trust it will not be encouraged in this country.

A chapter on the birds not to protect would add to the practical utility of the work.

McAlpine, D.—Handbook of Fungous Diseases of the Potato in Australia and their Treatment. Pp. iii + 215, 51 plts. and 25 text-figs. Melbourne: The Department of Agriculture, 1911.

The liability of the potato to disease and the difficulty often attendant on the investigation, owing to a complication of diseases, is only too well-known. The loss due to disease is enormous, thus in the United States the annual loss is estimated at £7,500,000, in New Zealand, in 1905, £200,000, in Germany, in 1908, the loss was estimated at £30,000,000. Any practical aid therefore that science can render in lessening such losses as these must be welcome.

Mr. McAlpine, in the handbook before us, has aided considerably in this work by giving us a carefully prepared account of the different diseases, the factors influencing disease, the life-histories of the various fungi, and a host of other valuable matters of the greatest importance.

Not the least valuable portion of this work is the space that has been devoted to illustrations. Upwards of one hundred and fifty figures are given, all of which are excellent, and represent an amount of investigation not apparent at first sight. Every disease treated of has been personally investigated, and the results here published form a most valuable contribution to the literature of economic mycology.

Rowland-Brown, H.—Butterflies and Moths at Home and Abroad. Pp. 271, 21 plts. and 8 text figs. London: T. Fisher Unwin, 1912. Price, 7s. 6d. net.

Mr. Rowland-Brown's handsome volume is sure of a welcome, for he has presented the beginner with lucid explanations free from technicalities, of a large number of insects, and distinctly good illustrations. The numerous figures of the larvae add greatly to the value of the twenty-one plates which contain nearly three hundred figures.

The work is divided into two parts, the first forming a general introduction and treating of such subjects as the uses of collecting and observation, descriptions of the egg, larvae, pupa, and the perfect insect, the terms employed to describe their structure, classification, rearing and breeding, distribution, immigration, colonisation, collecting, protective powers, etc. The second part is devoted to the descriptions of the different genera and species.

Sanderson, E. D., and C. F. Jackson.—Elementary Entomology. Pp. vii + 372 and 496 figs. Boston: Ginn and Co. 1912. Price, 8s. 6d. net.

The increasing demand for short courses in elementary entomology has led the authors to place the present work before teachers and students.

The work is divided into three parts, the first two treating of the structure and growth of insects and the classes of insects, whilst a third is devoted to laboratory exercises, all of which are profusely illustrated.

Throughout the information is brief, but suggestive, and emphasis is laid upon the necessity for the maximum of laboratory and field work. If the book has any serious fault it is the brevity of the information, directions, etc., in the laboratory exercises, which might profitably have been given much more fully.

CURRENT LITERATURE.

I.—General Subject.

Arkell, T. R.—Some Data on the Inheritance of Horns in Sheep. New Hampshire Agric. Exp. Stat., Bull. 160, 1912, pp. 1-35, 16 Tables and 43 figs.

II.—Anatomy, Physiology, and Development.

Dewitz, J.—Physiologische Untersuchungen auf dem Gebiet der Schädlingsforschung. Naturwiss. Zeit. f. Forst-u. Landwirts., 1912, pp. 539-549.

Hilton, W. A.—A Preliminary Study of the Central Nervous System of Spiders. Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 832-836, 3 figs.

Sharp, D., and F. Muir.—The Comparative Anatomy of the Male Genital Tube in Coleoptera. Trans. Entom. Soc. Lond., 1912, pp. 477-642, plts. 42-78.

Voss, F.—Über den Thorax von. *Gryllus domesticus.* Zeit. f. wiss. Zool., 1912, Bd. 101, pp. 579-682, Taf. 25-29.

III.—General and Systematic Biology, and Geographical Distribution.

Adie, Helen A.—Note on the Sex of Mosquito Larvae. Ann. Trop. Med. and Paras., 1912, vol. 6, pp. 463, 464, plt. xxvi.

Alexander, C. P.—The American species of *Adelphomyia,* Bergroth (*Tipulidae* Dipt.). Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 829-831, 1 fig.

Bacon, Gertrude.—Some Collembola of Laguna Beach. Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 839-845, 4 figs.

Bagnall, R. S.—Brief Records of *Chaetechylene vesuviana,* Newp., and other Myriopods new to the British Fauna. Zoologist, 1912, pp. 1-3.

Bagnall, R. S.—Some Considerations in regard to the Classification of the Order Thysanoptera. Ann. and Mag. N. H., 1912, ser. 8, vol. 10, pp. 220-222.

Bagnall, R. S.—*Cephalothrips monilicornis,* Reut. : an addition to the Thysanoptera of Great Britain. Entom. Mon. Mag., 1912, vol. 23, p. 190.

Bagnall, R. S.—Further Records of Some British Symphyla, with description of a new species. Trans. N. H. Soc. Northumberland, 1912, vol. 4, new ser., pp. 171-176.

Carter, H. F.—Descriptions of Three New African species of the Genus *Tabanus*. Ann. Trop. Med. and Paras., 1912, vol. 6, pp. 435-442, plt. xxiii.

Cockerell, T. D. A.—Names applied to the Eucerine Bees of North America. Proc. U.S. Nat. Mus., 1912, vol. 43, pp. 261-273.

Compere, G.—A Few Facts concerning the Fruit Flies of the World. II. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 842-845.

Essig, E. O.—Aphididae of Southern California. X. Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 758-797, 10 figs.

Essig, E. O.—Host Index to California Plant Lice. II. (*Aphididae*). Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 826-828.

Felt, E. P.—The Gall Midge Fauna of Western North America. Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 753-757.

Gee, W. P.—Preliminary List of the Scale Insects of South Carolina, with some notes on the Behaviour of *Lecanium quercifex*, Fitch. Journ. Econ. Entom., 1912, vol. 5, pp. 484-486.

Grandi, G.—Alcune notizie sui topi campagnoli che infestano le terre dell' Italia meridionale e il modo di combatterli. Boll. d. Ministero agric., 1912, An. 11, ser. C., 1912, pp. 1-4.

Hewitt, C. C.—*Fannia* (*Homalomyia*) *canicularis*, Linn., and *F. scalaris*, Fab. Parasitology, 1912, vol. 5, pp. 161-174, plt. vii and 7 figs.

Hilton, W. A.—Sensory Setae of Tarantula and some of its relatives. Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 810-817, 4 figs.

Hood, J. D.—New North American Thysanoptera. Proc. Entom. Soc. Washington, 1912, vol. 14, pp. 129-160, plts. 4-8.

Karny, H.—Gallenbewohnende Thysanopteren aus Java. Marcellia, 1912, vol. 11, pp. 115-169, 5 figs.

Kieffer, J. J.—Les Cecidomyies du Tamarix. Marcellia, 1912, vol. 11, pp. 169-172.

Malloch, J. R.—New American Dipterous Insects of the Family *Pipunculidae*. Proc. U.S. Nat. Mus., 1912, vol. 43, pp. 291-299, 9 figs.

Nakayama, S.—*Chilocorus simili*, Rossi, and its relation to Scale Insects in Japan. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 932-936, 1 fig.

Pantanelli, E.—Acariosi del Nasomozzo (*Staphylea pinnata*, L.). Marcellia, 1912, vol. 11, pp. 173-175, T. i.

Patch, Edith M.—Food Plant Catalogue of the Aphidae of the World. Pt. 1. Ibid., pp. 179-214.

Patch, Edith M.—Notes on Psyllidae. Ibid., pp. 215-234, 139 figs.

Pierce, W. D., and T. E. Holloway.—Notes on the Biology of *Chelonus texanus*, Cress. Journ. Econ. Entom., 1912, vol. 5, pp. 425-428.

Sasscer, E. R.—Catalogue of Recently Described *Coccidae*. IV. U.S. Dept. Agric., Bur. of Entom., Tech. Ser. No. 16, pt. vi, 1912, pp. 83-97.

Sasscer, E. R.—The Genus *Fiorina* in the United States. U.S. Dept. Agric., Bur. of Entom., Tech. Ser. No. 16, pt. v, 1912, pp. 75-82, plts. x-xiii.

Schrader, W.—Cool Air Experiment with *Junonia coenia*. Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 801-806, 1 fig.

Severin, H. H. P., and W. J. Hartung.—The Flight of Two Thousand marked male Mediterranean Fruit Flies (*Ceratitis capitata*, Wied.). Anns. Entom. Soc. America, 1912, vol. 5, pp. 400-407, plts. 29, 30 and 2 figs.

Splendore, A.—Collembolo dannoso ai semenzai di tabacco : *Isotomurus palustris* (Mull.), Born., var. *maculatus*, Schaeff. Boll. tec. d. R. Instituto sperimen. Scafati, 1912, Anno 11, pp. 147-151, 1 fig.

Weinland, H. A.—The Cosmopolitan Habits of the Fruit Fly (*Ceratitis capitata*, Wied.). Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 821-825, 2 figs.

Woodworth, C. W.—Check List of California Insects. III.-IV. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 914-919 and 941-948.

IV.—Agriculture and Horticulture.

Ballou, H. A.—The Cotton Boll Weevil. W.I. Bull., 1912, vol. 13, pp. 29-33.

Brooks, C.—Fungicides in the Apple Orchard. New Hampshire Agric. Exp. Stat., Bull. 161, 1912, pp. 1-15.

Bryant, H. C.—Some Insects and other Arthropods in the Diet of the Western Meadowlark. Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 807-809.

Chaine, J.—Influence des fortes chaleurs sur certains Insectes parasites de végétaux. Compt. Rendus, 1912, T. 154, pp. 1833-1836.

Chittenden, F. H.—The Cowper Weevil (*Pachymerus chinensis,* L.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 96, pt. vi, 1912, pp. 83-94, plt. i and 1 fig.

Chittenden, F. H.—The Potato-Tuber Moth (*Phthorimaea operculella,* Zell.). U.S. Dept. Agric., Bur. of Entom., Circ. No. 162, 1912, pp. 1-5, 3 figs.

Cleland, J. B.—Examination of Contents of Stomachs and Crops of Australian Birds. Second Rpt. Gov. Bur. Microbiology, Sydney, 1912, pp. 192-208.

Dewitz, J.—Bericht über die Tätigkeit der Station für Schädlingsforschungen in Metz fur die Jahre 1910 und 1911. Bericht Geisenheim fur 1911, 1912, pp. 218-295, 7 fign.

Essig, E. O.—The Raspberry Horn-tail (*Hartigia abdominalis*). Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 889-901, 11 figs.

Fawcett, H. S.—Citrus Scab, *Cladosporium citri,* Massee. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. i, pp. 833-842, 8 figs.

Fawcett, H. S.—Citrus Galls. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 937-940, 4 figs.

French, C., Jun.—Insect Pests of the New Zealand Flax. Journ. Dept. Agric. Victoria, 1912, vol. 10, pp. 720, 721, 2 figs.

Gee, W. P., and M. A. Ballard.—*Aspergillus* infecting *Malacosoma* at High Temperatures. Mycologia, 1912, vol. 4, pp. 279-281, 1 fig.

Gibson, A.—Blister Beetles. 42nd Ann. Rpt. Entom. Soc. Ontario, 1911, pp. 1-6, 8 figs.

Gibson, A.—The Entomological Record for 1911. Ibid., pp. 1-24.

Grimshaw, P. H.—The Food of the Common Pheasant. Scottish Nat., 1912, pp. 249-251.

Hedgcock, G. G., and W. H. Long.—Preliminary Notes on Three Rots of Juniper. Mycologia, 1912, vol. 4, pp. 109-114, plts. lxiv, lxv.

Hedges, Florence, and L. S. Tenny.—A Knot of Citrus Trees caused by *Sphaeropsis tumefaciens*. U.S. Dept. Agric., Bur. of Plant Indus., Bull. No. 247, 1912, pp. 1-74, 10 plts. and 8 text figs.

Hewitt, C. G.—The Large Larch Sawfly (*Nematus erichsonii*), with an account of its parasites, other natural enemies and means of control. Dom. of Canada, Dept. Agric., Div. of Entom., Bull. No. 10, second ser., 1912, pp. 1-42, plts. i-iv, and 21 figs.

Holloway, T. E.—The Poison Exponent: A Symbol of the Toxicity of Chemicals in their relation to Insects. Journ. Econ. Entom., 1912, vol. 5, pp. 452-456.

Howard, A., and G. L. C.—On the Inheritance of some characters in Wheat. I. Mem. Dept. Agric. India, Botanical Ser., 1912, vol. 5, pp. 1-46, plts. i-iii.

Howard, L. O., and C. H. Popenoe.—Hydrocyanic Acid Gas against Household Insects. U.S. Dept. Agric., Bur. of Entom., Circ. No. 163, pp. 1-8.

Hunter, W. D.—The Boll Weevil Problem. U.S. Dept. Agric., Far. Bull. 512, 1912, pp. 1-46, 9 figs.

Hyslop, J. A.—The Alfalfa Looper. U.S. Dept. Agric., Bur. of Entom., Bull. No. 95, Pt. vii, 1912, 109-118, plt. xi and 7 figs.

Jones, L. R., and others.—Investigations of the Potato Fungus *Phytophthora infestans*. U.S. Dept. Agric., Bur. of Plant Indus., Bull. No. 245, 1912, pp. 1-100, 10 plts. and 10 text figs.

Kell, D.—The "Longulus" Scale. Pomona Coll. Journ. Entom., 1912, vol. 4, pp. 798-800.

Lipman, C. B.—The Distribution and Activities of Bacteria in Soils of the Arid Region. Univ. Calif. Pub. in Agric. Sci., 1912, vol. 1, No. 1, pp. 1-20.

Marsh, H. O.—The Sugar-Beet Webworm (*Loxostege sticticalis*, L.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 109, pt. vi, 1912, pp. 57-70, 15 figs.

Morrill, A. W., and E. A. Back.—Natural Control of White Flies in Florida. U.S. Dept. Agric., Bur. of Entom., Bull. No. 102, 1912, pp. 1-78, plts. i-ix and 1 fig.

Osborn, H.—Leafhoppers affecting Cereals, Grasses, and Forage Crops. U.S. Dept. Agric., Bur. of Entom., Bull. No. 108, 1912, pp. 1-123, plts. i-iv and 29 figs.

Paddock, F. B.—The Sugar-Beet Web Worm. Journ. Econ. Entom., 1912, vol. 5, pp. 436-443, plt. 13.

Patch, Edith M.—Aphid Pests of Maine. Maine Agric. Exp. Stat., Bull. No. 202, 1912, pp. 160-178, 31 figs.

Popenoe, C. H.—Insects Injurious to Mushrooms. U.S. Dept. Agric., Bur. of Entom., Circ. No. 155, 1912, pp. 1-10, 6 figs.

Quaintance, A. L.—The Mediterranean Fruit-Fly. U.S. Dept. Agric., Bur. of Entom., Circ. No. 160, 1912, pp. 1-25, 1 fig.

Quaintance, A. L., and E. W. Scott.—The One-Spray Method in the Control of the Codling Moth and the Plum Curculio. Second Rpt. U.S. Dept. Agric., Bur. of Entom., Bull. No. 115, Pt. ii, 1912, pp. 87-112, 1 plt. and 4 figs.

Robbins, W. W.—Algae in some Colorado Soils. Colorado Agric. Exp. Stat., Bull. 184, 1912, pp. 24-36, plts. i-iv.

Russell, H. M.—The Bean Thrips (*Heliothrips fasciatus*, Pergande). U.S. Dept. Agric., Bur. of Entom., Bull. No. 118, 1912, pp. 1-45, 11 figs.

Russell, H. M., and F. A. Johnston.—The Life-History of *Tetrastichus asparagi*, Crawf. Journ. Econ. Entom., 1912, vol. 5, pp. 429-433.

Severin, H. H. P., and W. J. Hartung.—Will the Mediterranean Fruit Fly (*Ceratitis capitata*, Wied.) breed in Bananas under artificial and field conditions? Journ. Econ. Entom., 1912, vol. 5, pp. 443-451, 1 fig.

Vaile, R. S.—Wilt of the Black-eye Bean. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 912, 913, 1 fig.

Washburn, F. L.—14th Report of the State Entomologist of Minnesota. Minn. Agric. Exp. Stat., 1912, pp. xiii + 114, 3 coloured plts. and 73 figs.

Webster, F. M., and W. J. Phillips.—The Spring Grain-Aphis or "Green Bug." U.S. Dept. Agric., Bur. of Entom., Bull. No. 110, 1912, pp. 1-153, plts. i-ix and 48 figs.

Weinland, H. A.—The Present Fruit Fly Situation and some results of the Hawaiian Campaign. Mon. Bull. State Comms. Hort., Sacr., Cal., 1912, vol. 1, pp. 845-855, 5 figs.

Weiss, H. B.—Notes on *Lixus concavus*. Journ. Econ. Entom., 1912, vol. 5, pp. 434-436.

Woodhouse, E. J., and T. B. Fletcher.—The Caterpillar Pest of the Mokameh Tal Lands. Agric. Journ. India, 1912, vol. 7, pp. 343-354, map.

V.—Forestry.

Buttrick, P. L.—Notes on Insect Destruction of Fire-killed Timber in the Black Hills of South Dakota. Journ. Econ. Entom., 1912, vol. 5, pp. 456-464, 3 figs.

Hedgcock, G. G.—Notes on some Western *Uredineae* which attack Forest Trees. Mycologia, 1912, vol. 4, pp. 141-147.

Spaulding, P.—Notes upon Tree Diseases in the Eastern States. Mycologia, 1912, vol. 4, pp. 148-151.

VI.—Fisheries.

Fantham, H. B., and Annie Porter.—Some Effects of the Occurrence of Myxosporidia in the Gall Bladder of Fishes. Ann. Trop. Med. and Paras., 1912, vol 6, pp. 467-481.

VII.—Medicine.

Blacklock, B.—On the Resistance of *Cimex lectularius* to various reagents, powders, liquids and gases. Ann. Trop. Med. and Paras., 1912, vol. 6, pp. 415-428.

Brues, C. T.—Blood-sucking Insects as Carriers of human Diseases. Proc. Entom. Soc. Washington, 1912, vol. 14, pp. 180, 181.

Howlett, F. M.—Yellow Fever and Mosquitos. Agric. Journ. India, 1912, vol. 7, pp. 364-367.

Kinghorn, A., and others.—On the Development of *Trypanosoma rhodesiense* in *Glossina morsitans*. Ann. Trop. Med. and Paras., 1912, vol. 6, pp. 495-503.

VIII.—Animal Diseases, Etc.

Blacklock, B.—The Resistance of *Ornithodorus moubata* to various sheep-dips. Ann. Trop. Med. and Paras., 1912, vol. 6, pp. 429-433.

Hayes, F. M.—Hog Cholera and Preventive Serum. Agric. Exp. Stat., Berkeley, Cal., Bull. No. 229, 1912, pp. 1-22, 10 figs.

Hooker, W. A., and others.—The Life-History and Bionomics of some North American Ticks. U.S. Dept. Agric., Bur. of Entom., Bull. No. 106, 1912, pp. 1-239, plts. i-xv and 17 figs.

Kinghorn, A., and W. Yorke.—Further Observations on the Trypanosomes of Game and Domestic Stock in North-Eastern Rhodesia. Ann. Trop. Med. and Paras., 1912, vol 6, pp. 483-493.

Tidswell, F.—Second Report of the Government Bureau of Microbiology for the Years 1910 and 1911. Pp. 244. Sydney: W. A. Gullick, 1912. Price, 5s.

An excellent summary of a vigorous, active and practical organisation.

IX.—Commercial.

Misra, C. S.—The Cultivation of Lac in the Plains of India (*Tachardia lacca*, Kerr). Agric. Research Inst. Pusa, Bull. No. 28, 1912, pp. 1-32, plts i-x and 5 figs.

THE

JOURNAL OF ECONOMIC BIOLOGY.

THE BRITISH SPECIES OF THE GENUS *MACROSIPHUM*, PASSERINI.

Pt. I.

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With 30 Figures.

Contents.

I.—Introduction.

This paper deals with the species of the Aphid genus *Macrosiphum*, so far known to occur in Britain. Six of Buckton's species I have been unable to find. His specimens (presumably the types) are in

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the British Museum, and these are undoubtedly good species. The genus was formerly called *Siphonophora* by Koch, and this name was used by Ferrari, Buckton, and many others.

In America the genus was named by Oestlund *Nectarophora*. Schouteden first pointed out that Passerini's genus *Macrosiphum* had precedence.

So far fifty-five species are recorded for Britain, of which number twelve are new species. I have two others from *Cichorium intybum*, which I at present cannot place.

The second part of this paper will appear in the next number.

The synonomy of the genus is as follows:—

Macrosiphum, Passerini.

nec. Oestlund, nec. Del. Guercio.

Nectarophora, Oestlund.
Siphonophora, Koch.

The characters of the genus are well defined in most of the species, but in some there is a mergence into *Aphis*. One species placed by Buckton in this genus, *M. rosarum*, Walker (non Kaltenbach), I have excluded from the genus. The following are the generally accepted characters:—

Antennae long, as long as, or longer than the body, the third segment longer than the fourth, with numerous sensoria in the alate forms; with one to a few on the third segment in the apterous females; antennae arising from *prominent frontal tubercles*. There are six segments only to the antennae, not seven, as usually mentioned, the sixth segment being usually the longest. The cauda is long and lanceolate or ensiform.

The cornicles are large, usually long, thin and cylindrical, but may be shortened and thick.

The males that are known are alate, and the oviparous females apterous.

Legs long and slender. The wings normal. Really the distinguishing character is the presence of long antennae arising from prominent frontal lobes.

II.—List of British Species.

1. *Macrosiphum rosae* (Linnaeus).
   Apris rosae, Linnaeus.
   Siphonophora rosae, Koch and Buckton.
   Aphis dipsaci, Schrank.

2. *Macrosiphum granarium* (Kirby).
   Aphis granaria, Kirby.
   Aphis cerealis, Kaltenbach.
   Siphonophora cerealis, Koch.
   Siphonophora granaria, Buckton.
   Aphis hordei, Kyber (nom nud).

3. *Macrosiphum scabiosae* (Schrank).
   Aphis scabiosae, Schrank.
   Siphonophora scabiosae, Buckton.

4. *Macrosiphum solidaginis* (Fabricius).
   Aphis solidaginis, Fabricius.
   Siphonophora solidaginis, Koch and Buckton.

5. *Macrosiphum sonchi* (Linnaeus).
   Aphis sonchi, Linnaeus.
   Siphonophora achilleae, Koch.
   Siphonophora sonchi, Passerini and Buckton.
   Siphonophora lactucae, Koch non Fabricius.

6. *Macrosiphum sisymbrii* (Buckton).
   Siphonophora sisymbrii, Buckton.

7. *Macrosiphum jaceae* (Linnaeus).
   Aphis jaceae, Linnaeus.
   Aphis cardui, Boyer.
   Aphis cirsii, Gmelin.
   Aphis sonchi, Walker (part).
   Siphonophora jaceae, Koch and Buckton.

8. *Macrosiphum muralis* (Buckton).
   Siphonophora muralis, Buckton.

9. *Macrosiphum absinthii* (Linnaeus).
   Aphis absinthii, Linnaeus.
   Aphis balsamitae, Müller.
   Siphonophora absinthii, Koch, Passerini and Buckton.

10. *Macrosiphum artemisiae* (Boyer non Koch).
   Aphis artemisiae, Boyer.
   Aphis tanacetaria, Kaltenbach.

11. *Macrosiphum lilacinum* (Ferrari).
   Siphonophora lilacina, Ferrari.

12. *Macrosiphum tanaceticolum* (Kaltenbach).
   Aphis tanaceticola, Kaltenbach.
   Siphonophora tanaceticola, Passerini and Buckton.

13. *Macrosiphum tanaceti* (Linnaeus).
Aphis tanaceti, Linnaeus.
Siphonophora tanaceti, Koch and Buckton.

14. *Macrosiphum millefolii* (Fabricius).
Aphis millefolii, Fabricius.
Siphonophora millefolii, Koch and Buckton.

15. *Macrosiphum taraxaci* (Kaltenbach).
Aphis taraxaci, Kaltenbach.

16. *Macrosiphum olivatum* (Buckton).
Siphonophora olivata, Buckton.

17. *Macrosiphum campanulae* (Kaltenbach).
Aphis campanulae, Kaltenbach.
Siphonophora campanulae, Koch.

18. *Macrosiphum luteum* (Buckton).
Siphonophora lutea, Buckton.

19. *Macrosiphum lactucae* (Schrank).
Aphis lactucae, Schrank.
Aphis ribicola, Kaltenbach.
Siphonophora ribicola, Koch.
Siphonophora lactucae, Buckton and Passerini (non Koch).
Aphis ribis, Frisch.

20. *Macrosiphum kaltenbachii* (Schouteden).
Siphonophora alliariae (?), Koch.

21. *Macrosiphum hieracii* (Kaltenbach).
Aphis hieracii, Kaltenbach.
Siphonophora hieracii, Koch and Buckton

22. *Macrosiphum duffieldii,* n. sp.

23. *Macrosiphum primulae,* n. sp.

24. *Macrosiphum aquilegiae,* n. sp.

25. *Macrosiphum veronicae,* n. sp.

26. *Macrosiphum convolvuli* (Kaltenbach).
Aphis convolvuli, Kaltenbach.
Siphonophora convolvuli, Buckton.
Aphis vincae, Walker.

27. *Macrosiphum polygoni* (Buckton).
Siphonophora polygoni, Buckton.

28. *Macrosiphum scrophulariae* (Buckton).
Siphonophora scrophulariae, Buckton.

29. *Macrosiphum circumflexum* (Buckton).
    Siphonophora circumflexa, Buckton.

30. *Macrosiphum longipennis* (Buckton).
    Siphonophora longipennis, Buckton.

31. *Macrosiphum avellanae* (Schrank).
    Aphis avellanae, Schrank.
    Aphis coryli, Mosley.
    Siphonophora avellanae, Koch and Buckton.

32. *Macrosiphum tussilaginis* (Walker).
    Aphis tussilaginis, Walker.
    Siphonophora tussilaginis, Koch.

33. *Macrosiphum diplantereae* (Koch).
    Siphonophora diplantereae, Koch.

34. *Macrosiphum menthae* (Buckton).
    Siphonophora menthae, Buckton.

35. *Macrosiphum fragariae* (Koch).
    Siphonophora fragariae, Koch.

36. *Macrosiphum fragariellum* (Theobald).
    Siphonophora fragariella, Theobald.

37. *Macrosiphum rogersii,* n. sp.
    Siphonophora fragariae, Buckton, non Koch—part.

38. *Macrosiphum chelidonii* (Kaltenbach).
    Aphis chelidonii, Kaltenbach.
    Siphonophora chelidonii, Koch and Buckton. (?)

39. *Macrosiphum solani* (Kaltenbach).
    Aphis solani, Kaltenbach.

40. *Macrosiphum dirhodum* (Walker).
    Aphis dirhoda, Walker.
    Siphonophora dirhoda, Buckton.

41. *Macrosiphum pelargonii* (Kaltenbach).
    Aphis pelargonii, Kaltenbach.
    Aphis pallidae, Walker.
    Siphonophora pelargonii, Koch, Buckton.

42. *Macrosiphum urticae* (Schrank).
    Aphis urticae, Schrank.
    Siphonophora urticae, Buckton.
    Siphonophora carnosa (var.), Buckton.

43. *Macrosiphum pisi* (Kaltenbach).
Aphis pisi, Kaltenbach.
Siphonophora pisi, Koch, Buckton and Passerini.
Nectarophora destructor, Johnson.
Aphis pisum, Harris.
Nectarophora pisi, Sanderson.
Aphis lathyri, Walker.
Aphis onobrychis, Boyer. (?)

44. *Macrosiphum ulmariae* (Schrank).
Aphis ulmariae, Schrank.

45. *Macrosiphum gei* (Koch).
Siphonophora gei, Koch.

46. *Macrosiphum trifolii*, n. sp.

47. *Macrosiphum loti*, n. sp.

48. *Macrosiphum stellariae*, n. sp.

49. *Macrosiphum crataegaria* (Walker).
Aphis crataegraia, Walker (non Buckton).

50. *Macrosiphum sileneum*, n. sp.

51. *Macrosiphum arundinis*, n. sp.

52. *Macrosiphum graminum*, n. sp.

53. *Macrosiphum agrostemnium*, nov. nom.
Siphonophora cichoni, Buckton (partly) non Koch.

54. *Macrosiphum githago*, nov. nom.
Siphonophora cichoni, Buckton, part non Koch.

55. *Macrosiphum rubiella*, n. sp.

III.—List of Plant Hosts with their Species of Macrosipha.

Plant.		Macrosiphum.
Achillea millefolia ...	...	M. millefolii, Fabricius.
,, ,, ...	...	M. artemisiae, Boyer.
Achillea ptarmica ...	...	M. millefolii, Fabricius.
Artemisia vulgaris ...	...	M. artemisiae, Boyer.
Artemisia absinthia ...	...	M. artemisiae, Boyer.
,, ,, ...	...	M. absinthii, Linnaeus.
Artemisia abrotana ...	...	M. absinthii, Linnaeus.
Alliaria officinalis ...	...	M. kaltenbachii, Schouteden.
Alsine sp. ...	...	M. jaceae, Linnaeus.
Agrostemma githago	...	M. agrostemmum, n. n.
,, ,,	...	M. githago, n. n.

Plant.		Macrosiphum.
Aquilegia vulgaris ...	...	M. aquilegiae, n. sp.
Avena fatua ...	...	M. granarium, Kirby.
Arundinis ...	...	M. arundinis, n. sp.
Bromus mollis ...	...	M. granarium, Kirby.
Chrysanthemum segetum	...	M. sonchi, Linnaeus.
Chrysanthemum (cultivated)	...	M. pelargonii, Buckton.
,, ,, ...	...	M. circumflexum, Buckton.
,, ,, ...	...	M. campanulae, Kaltenbach.
Cineraria, sp. ...	...	M. pelargonii, Buckton.
,, ,, ...	...	M. circumflexum, Buckton.
Chelidonium majus ...	...	M. urticae, Schrank.
,, ,, ...	...	M. chelidonii, Kaltenbach.
Capsella bursa-pastoris	...	M. pisi, Kaltenbach.
Campanula rotundifolia	...	M. campanulae, Kaltenbach.
Crataegus oxyacanthae	...	M. crataegaria, Walker.
Crepis viridis ...	...	M. lactucae, Schrank.
Crepis biennis ...	...	M. sonchi, Linnaeus.
Centaurea cyanus ...	...	M. jaceae, Linnaeus.
,, ,, ...	...	M. solidaginis, Fabricius.
Centaurea nigra ...	...	M. jaceae, Linnaeus.
,, ,, ...	...	M. sonchi, Linnaeus.
Centaurea nigrescens	...	M. jaceae, Linnaeus.
Carduus acanthoides	...	M. jaceae, Linnaeus.
Carduus crispus ...	...	M. jaceae, Linnaeus.
Carduus lanceolatus	...	M. olivatum, Buckton.
Carduus nutans ...	...	M. sonchi, Linnaeus.
,, ,, ...	...	M. jaceae, Linnaeus.
Corylus avellanae ..	...	M. avellanae, Schrank.
Convolvulus major ...	...	M. convolvuli, Kaltenbach.
Convolvulus minor ...	...	M. convolvuli, Kaltenbach.
Cyclamen, sp.? ...	...	M. circumflexum, Buckton.
Dactylis glomerata ...	...	M. dirhodum, Walker.
Diplantera formosa ...	...	M. diplanteriae, Koch.
Euphorbia cyparissia	...	M. cyparissiae, Koch.
Fresia, sp.	...	M. circumflexum, Buckton.
Fragaria, sp. ...	...	M. fragariae, Koch.
,, ,, ...	...	M. fragariellum, Theobald.
,, ,, ...	...	M. rogersii, n. sp.
Geranium robertarium	...	M. urticae, Schrank.
Geranium, sp. ...	...	M. pelargonii, Kaltenbach.
,, ,, ...	...	M. urticae, Schrank.
Geum urbanum ...	...	M. gei, Koch.
Glyceria fluitans ...	...	M. dirhodum, Walker.

Plant.		Macrosiphum.
Holcus, sp. ...	...	M. dirhodum, Walker.
Hordeum murinum ...	...	M. dirhodum, Walker.
Hieracium sylvestre	...	M. sonchi, Linnaeus.
,, ,, ...	...	M. hieracii, Kaltenbach.
Hieracium murorum	...	M. hieracii, Kaltenbach.
Hieracium pilosellae	...	M. hieracii, Kaltenbach.
Hieracium varietis ...	...	M. hieracii, Kaltenbach.
Lactuca muralis ...	...	M. muralis, Buckton.
Lactuca, sp. ...	...	M. lactucae, Schrank.
Lathyrus sylvestris ...	...	M. pisi, Kaltenbach.
Lapsana communis	...	M. sonchi, Linnaeus.
Lotus corniculatus ...	...	M. loti, n. sp.
Lecanthemum vulgare	...	M. artemisiae, Boyer.
Leontodon taraxacum	...	M. taraxaci, Kaltenbach.
Lilium, spp. ...	...	M. pelargonii, Buckton.
,, ,, ...	...	M. circumflexum, Buckton.
Malva sylvestris ...	...	M. urticae, Schrank.
Malva, sp. ...	...	M. pelargonii, Buckton.
,, ,, ...	...	M. diplantereae, Koch.
Mespilus germanica ...	...	M. pelargonii, Buckton.
Mentha viridis ...	...	M. menthae, Buckton.
Nemophila, sp. ...	...	M. convolvuli, Kaltenbach.
Nicotina rustica ...	...	M. scabiosae, Schrank.
Orchidaceae ...	...	M. lutea, Buckton.
Picris hieracoides ...	...	M. sonchi, Linnaeus.
,, ,, ...	...	M. kaltenbachii, Schouteden.
Persimmon ...	...	M. circumflexum, Buckton.
Poa annua ...	...	M. longipennis, Buckton.
Primula vulgaris ...	...	M. primulae, n. sp.
Primula kewensis ...	...	M. primulae, n. sp.
Pyretheum, sp. ...	...	M. millefolii, Fabricius.
Pisum, spp. ...	...	M. pisi, Kaltenbach.
Polygonum persicariae	...	M. granarium, Kirby.
,, ,, ...	...	M. polygoni, Buckton.
,, ,, ...	...	M. dirhodum, Walker.
Rosa, spp. ...	...	M. rosae, Linnaeus.
,, ,, ...	...	M. dirhodum, Walker.
Ribes, spp. ...	...	M. lactucae, Schrank.
Rubus fruticosus ...	...	M. chelidonii, Kaltenbach?
,, ,, ...	...	M. cyparissiae, Koch?
Rubus idaeus ...	...	M. chelidonii, Kaltenbach?
Ruta graveolenti ...	...	M. jaceae, Linnaeus.
Scrophularia scorodonia	...	M. scrophulariae, Buckton.

PLANT.		MACROSIPHUM.
Sarothammus scoparius	...	M. menthae, Buckton.
Sisymbrium officinale	...	M. sisymbrii, Buckton.
Serratula arvensis ...	...	M. sonchi, Linnaeus.
Stellaria graminea ...	...	M. cerastii, Kaltenbach.
Spiraea ulmaria ...	...	M. ulmariae, Schrank.
Schizanthus, sp. ...	...	M. circumflexum, Buckton.
Scabiosa arvense ...	...	M. solidaginis, Fabricius.
,, ,, ...	...	M. jaceae, Linnaeus.
,, ,, ...	...	M. scabiosae, Schrank.
Scabiosa succisa ...	...	M. scabiosae, Schrank.
,, ,, ...	...	M. cyparissiae, Koch.
Scabiosa columbaria	...	M. scabiosae, Schrank.
Solanum tuberosum ...	...	M. solani, Kaltenbach.
,, ,, ...	...	M. sonchi, Linnaeus.
,, ,, ...	...	M. lactucae, Schrank.
Sonchus oleraceus ...	...	M. jaceae, Linnaeus.
,, ,, ...	...	M. sonchi, Linnaeus.
Sonchus machrophyllum	...	M. kaltenbachii, Schouteden
Solidago virgaurea ...	...	M. solidaginis, Fabricius.
Silene inflata ...	...	M. sileneum, n. sp.
Trifolium procumbens	...	M. trifolii, n. sp.
Tussilago farfara ...	...	M. tussilaginis, Walker.
Trifolium pratensis ...	...	M. pisi, Kaltenbach.
Trifolium hybridum ...	...	M. pisi, Kaltenbach.
Trifolium repens ...	...	M. pisi, Kaltenbach.
Tanacetum vulgare ...	...	M. lilacium, Ferrari.
Tulipa ...	...	M. circumflexum, Buckton.
,, ...	...	M. duffieldii, n. sp.
Triticum sativum ...	...	M. dirhodum, Walker.
Urtica dioica ...	...	M. urticae, Schrank.
Vinca major ...	...	M. convolvuli, Kaltenbach.
Vinca minor ...	...	M. convolvuli, Kaltenbach.
Veronica beccabungae	...	M. veronicae, n. sp.

IV.—LIST OF SPECIES.

1. Macrosiphum rosae (Linn.).

Aphis rosae, Linn.
Siphonophora rosae, Koch.
Aphis dipsaci, Schrank.

Syst. Nat., I, II, 734. 9, Linn.; Mem., III, pl. 21, f. 1-4. Reaumur; Syst. Rhyng., 298, 30. Ent. Syst., IV, 217, 30, Fabr.; Ins. 3, 65, 10, tab. 3, f. 10, De Geer; Fn. Boic., II, 117, Schk.; Fn. Boic., 2, 104, n, 1181 (*dipsaci*), Schk.; Puc. de. Rosier Gotz. Ent. Beitr., II, 296, 9. Pflanzenlause, 3, I, Kalt.; Pflanzenlause, 178, Koch; Mon. Brit. Aph., I, 103, Buckton.

The commonest British rose aphis, and frequently very destructive.

Wingless viviparous female.—Head, thorax and abdomen green or reddish, with long black cornicles slightly swollen at their base, and usually slightly curved, but by no means always, their apex with irregular hexagonal reticulation, the remainder imbricated; cauda large, ensiform, yellowish, with eight lateral chaetae and two

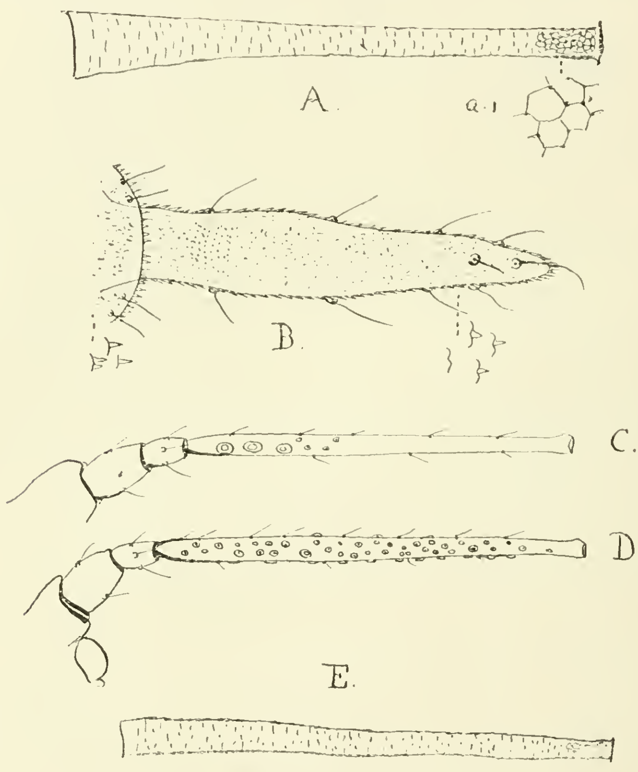

Fig. 1.—*Macrosiphum rosae* (Linn.).
A, Cornicle; B, Cauda; C, Antenna of apterous female. D, Antenna; E, Cornicle of alate female.

median apical ones. Antennae very long, dark, arising from marked frontal tubercles, the third segment with three or more (3 to 5) large sensoria at the base, and traces of 3 to 5 small ones (probably only mammilate chaetal areas); fourth segment about two-thirds the length of the third, fifth slightly shorter than the fourth, sixth about as long as the two preceding.

Legs long, similar in colour to the body, apex of femora and tibiae black, also the tarsi. Eyes red to reddish-brown.

The red variety shows exactly the same structure of cornicles, cauda and antennae.

Alate viviparous female.—Head, pronotum, scutum, thoracic lobes and scutellum black, a narrow green band between the head and pronotum, rest of thorax green. Abdomen shiny, bright green, three large black spots on each side behind the cornicles, a black patch at their base, and a black crescent-shaped mark in front of them, two dark spots behind the cornicles, and sometimes a dark patch on the last segment. Antennae very long, black, the third segment with forty-two to forty-eight sensoria over its entire length; fourth shorter than the third; fifth about as long as the fourth; sixth shorter than four and five combined; some of the hairs capitate.

Legs yellowish-green, with broad black areas on the apices of the femora and tibiae, and black tarsi. Cauda long, green. Cornicles long and thin, black, the apices reticulate, remainder imbricated. Eyes red.

Wings with yellow insertions, and cubitus, pale brownish stigma and veins.

Length.—3 to 3.5 mm. *Wing expanse*, 7.5 to 8 mm.

Oviparous female.—Apterous, rusty-red. Antennae short, about half the length of the body. Eyes red; cornicles black, shorter in proportion than in the viviparae. Posterior tibiae with many sensoria. Legs dusky to black.

Length.—1.2 to 1.5 mm.

Localities.—Found all over Britain and Europe.

Food plants.—Roses (*Rosa, spp.*) of all kinds, both wild and cultivated.

Life-History.—The winter is passed in two stages, namely, in in the egg stage and as apterous viviparae. The ova are laid as a rule near a bud or in the axils of the buds. They are laid in November and December. At first they are dirty yellow, but in a few days become shiny black. When fresh the ova are covered with a glutinous slime, by which they are held firmly on to the plant. A single female lays from four two six ova. I have never been able to find the male, and know of no definite description. It is said to be winged, and according to Walker has a black head, dark thorax and green abdomen. Buckton, on the other hand, figures what he considers to be the male (Plate III, fig. 4), and says that the general colour is reddish-green, with very long wings, long black cornicles, and dark marks on the thorax and abdomen.

In warm winters a sexual reproduction may go on all the time, especially on roses against walls.

Alate females occur in June, and fly from bush to bush, and in an incredible time found large colonies on the shoots, frequently smothering them, and this goes on all through the summer.

They are subject to much variation in colour, some being red, others pink, and with the dark markings more or less distinct, in some cases entirely absent.

Variety *glauca*, Buckton.

2. **Macrosiphum granarium** (Kirby-Buckton).

Aphis granaria, Kirby.
Aphis cerealis, Kaltenbach.
Siphonophora cerealis, Koch.
Aphis hordei, Kyber (nom. nud.).

Linn. Soc. Trans , IV, p. 238, Kirby; Journ. Roy. Agric. Soc., VI, Curtis; Mono. Brit. Aph., I, p. 114, pl. VI, Buckton; Mono. Pfianz., p. 16, 6, Kaltenbach; Germ. Mag. Zeit., II, Kyber; (nom nud).

Apterous viviparous female.—Green to yellowish-green. Antennae as long or longer than the body, deep brown; frontal tubercles moderately developed, divergent; the third segment longer than the fourth, the fourth than the fifth, the sixth slightly longer than the

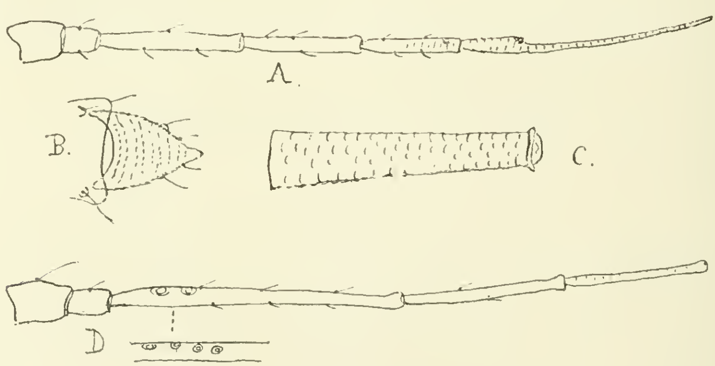

Fig. 2.—*Macrosiphum granarium* (Kirby).
A, Antenna of larva; B, Cauda of larva; C, Cornicle of larva.
D, Antenna of apterous female.

fourth and fifth together, with small hairs, four to no sensoria at the base of segment three. Rostrum dark at the apex, reaching to nearly the third coxae. Cornicles black, moderately long, expanded at the base; reticulate at the apex, rest minutely imbricated.

Cauda long, pale yellowish-green, about two-thirds the length of the nectaries, lanceolate with one or two constrictions, three pairs of lateral bristles, two median and one median apical one.

Legs green, except most of the femora, which are dark brown, and the apices of the tibiae and tarsi, which are dark brown; tibiae and femora with short hairs, especially the former. Eyes black to dull red. The abdomen may have five pairs of lateral dusky spots, but they are often absent.

Length.—2.5 to 2.8 mm.

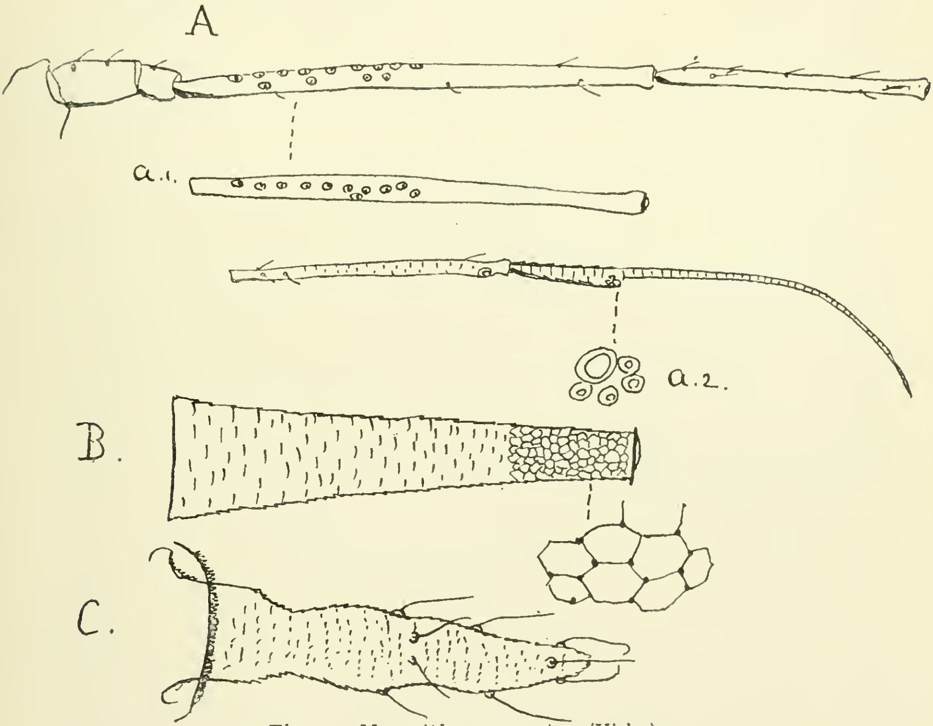

Fig. 3.—*Macrosiphum granarium* (Kirby).
Alate female. A, Antenna; *a1*, Variation in sensoria; *a2*, Sensoria of sixth segment; B, Cornicle; C, Cauda.

Alate viviparous female.—Pale brownish-green to dull yellowish-brown, or green, thorax darker with dark brown lobes and dark scutellum. Antennae dark brown, longer than the body; the third segment wih nine to fourteen sensoria extending for more than half the length of the segment, fourth shorter than the third, fifth slightly shorter than the fourth. Proboscis reaching to the second coxae, black at the apex. Abdomen green, with four pairs of lateral black spots in front of the cornicles, and below these three more pairs of elongated spots. Cauda pale green, long, constricted at the base.

Cornicles black, expanded at the base, moderately long, the apex for about one-third of the length reticulate, rest minutely imbricated. Legs green, femora black except at the base, and the apex of the tibiae and tarsi dark.

Wings with green insertions, pale brown stigma and veins.

Length.—2 to 2.5 mm. *Wing expanse*, 7 to 8 mm.

Localities.—Probably found all over the country. Wye (1/7 to 14/9); Cambridge (1/7/09); Kingston-on-Thames (1/6 and 14/7 and 2/8/1887); St. Neots and Great Staughton (1/7/06); London (14/12/04).

Food Plants.—Oats (*Avena*); Wheat (*Triticum*); Barley (*Hordeum*); *Avena faluae, Bromus mollis*, and *Dactylis glomerata*. Kaltenbach also gives *Secale cereale, Triticum sativum, Hordeum murinum, Holcus, Poa* and other grasses. Walker gives *Glyceria fluitans* and *Polygonum persicariae*.

Life-history.—This aphis appears on the corn, as far as I have been able to observe, as the alate viviparous female in June, and only in small numbers. The winged females settle under the blade and produce colonies of young, which go on breeding until July and August, when another alate brood appears, and these crawl and fly up to the ear, where they often cluster in numbers. On the corn ripening they disperse, and I have found them as late as October 14th feeding and reproducing on some self-sown, wayside wheat and on Meadow Foxtail grass.

No sexuparae have yet been found, either here or in America, so that we do not know how the winter is passed.

Notes.—I have placed Kaltenbach's *Aphis cerealis* as a synonym of this species, for the reason that I have been unable to separate two European Macrosipha on any structural characters, and from the description I see no reason to think it otherwise than Kirby's, Curtis', and Buckton's granaria. When one considers the variation in colour and markings seen in a single colony arising from one female it is impossible to separate the two. The general sensorial arrangement varies to some extent, for instance, in the apterae from 0 to 4 on segment three of the antennae, but the cornicles agree in sculpture, but vary in relative length and thickness in a single brood.

Pergande (Bull. 44, Div. Ent., U.S. Dept. Agric., pp. 13-21, 1904) separates these two on account of the abdominal maculations, the comparative length of the antennal segments, the nectaries, and the last fork of the wings by the measurement of the wings by tenths.

I have found in England that these characters do not seem to

hold good. His *cerealis,* he says, had an unornamented abdomen, and the antennae and nectaries are constantly shorter.

The name *hordei,* Kyber, may be discarded, as the species was never described (German's Mag. Ent., I, pt. 2, p. 11, 1815).

Buckton also gives with a ? *Aphis avenae,* Fabricius, as a synonym. This is quite a distinct species, coming in the genus *Siphocoryne,* and is the same as the Apple Aphis known as *Aphis fitchii,* Sanderson. Kirby's species might be *avenae* (Linn. Soc., IV, p. 238, 1798), but I do not think so.

The insect described as *granaria* recorded by Curtis (Farm Insects, p. 289), and figured Plate *j,* figs. 10, 11, 13, is evidently this insect, although later he refers to it as *Aphis avenae,* Fabr., (p. 499).

3. **Macrosiphum scabiosae** (Schrank).

Aphis scabiosae, Schrank.
Siphonophora scabiosae, Buckton.

Fn. Boic., II, 105, 1082, Schrank; Mono. Pflanz., p. 60, Kaltenbach; Ann. Soc. Ent. Fr., X, p. 179, 19, Fonscolomb; Mon. Brit. Aph., I, 112, Buckton.

Apterous viviparous female.—Bright green with darker markings, or dull reddish with darker markings. Cornicles long and black, the extreme apex with irregular hexagonal reticulation, the rest imbricated. Cauda fairly long, pale yellowish to pale dusky yellow, with a basal constriction and eight long lateral hairs and two smaller sub-apical ones. Antennae dark, with paler areas to the third and fourth segments, the third with a series of 3 to 5 sensoria on the basal half, the fourth segment rather more than half the length and narrower, fifth shorter than the fourth. Legs green with dark apices to femora and tibiae. Eyes red.

Alate viviparous female.—Yellowish-green to green, head and antennae black; thoracic lobes and pronotum black. Abdomen with black lateral spots. Cauda long, green to dusky-green. Cornicles long, black, the apices reticulate, remainder imbricated. Legs yellowish-green on the femora, except at the apex, rest black. The third segment of the antennae with many sensoria over its whole length, the fourth showing three small sensoria, shorter than the third, the fifth shorter than the fourth.

Wings with yellowish cubitus, stigma and veins.

Length.—2.5 to 3 mm.

Larva.—The larva is green with shorter cornicles, showing no apical reticulation, but faint imbrication, which becomes more

prominent from the apical third. The cauda is triangular and small, and the antennae are comparatively short, the third, fourth and fifth segments being nearly equal, but gradually decrease in size, sixth segment longer than the two preceding.

The antennae are more hairy than in the adults, and the legs shorter and thicker.

Localities.—Wye (15/6/11) on garden scabious; and 17/7/1912 on wild scabious; Ventnor, Isle of Wight (27/4/11); Colemans Hatch, Sussex (14/7/12); Hawksfold, near Fernhurst, Sussex (Buckton); Brussels (Schouteden); Germany (Kaltenbach).

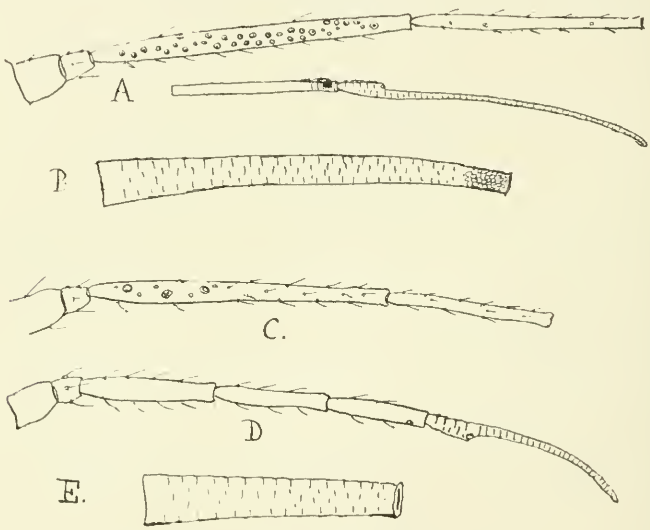

Fig. 4.—*Macrosiphum scabiosae* (Schrank).
A, Anteana; B, Cornicle of alate female. C, Antenna of apterous female.
D, Antenna; E, Cornicle of larva.

Food Plants.—Buckton records it as clustering round the flower stalks of *Scabiosa succisa* in August.

Forster records it on *Nicotina rustica.* Schouteden from *Scabiosa columbaria.* Kaltenbach from *Scabiosa arvense,* in June and July.

In Kent it occurs on both wild and cultivated scabious, hatching in May and occurring through the year, but I have not collected the sexuparae.

Notes.—Schouteden[1] evidently considers the insect described by Buckton to be distinct from that described by Schrank. Kalten-

[1] Cat. d. Aph. d. Belg., 240, 1906, Schouteden.

bach's[1] description answers to Schrank's, and also to Buckton's, except that Buckton details the tail as green, Kaltenbach as dark green. From specimens I have examined the original description applies to both, and as the species exhibits much variation I feel confident the three descriptions apply to the same.

Koch[2] does not mention this species.

4. **Macrosiphum solidaginis** (Fabricius).

Aphis solidaginis, Fabricius.
Siphonophora solidaginis, Koch and Buckton.

Ent. Syst., IV, p. 211, n. 5, Fabricius; Syst. Rhyn., p. 225, no. 5, Fabricius; Illiger Mag., I, p. 442, n. 1, Hausmann; Mono. Pflanz., p. 32, Kaltenbach; Die Pflanz., p. 197, figs. 269 270, Koch; Mono. Brit. Aph., I, p. 156, Pl. xxv, Buckton.

Alate viviparous female.—Head and thorax deep black, shiny; abdomen various shades of deep red. Antennae black on the first two segments and the last, others pale, the third segment has thirty-two to forty sensoria spread over the whole length except just at the apex, with a few comparatively large hairs on one side.

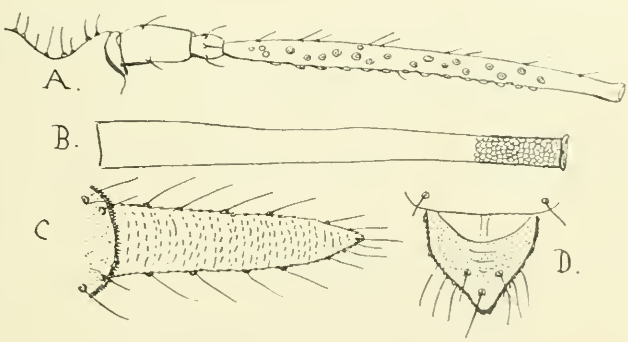

Fig. 5.—*Macrosiphum solidaginis* (Fabr.).
A, Antenna; B, Cornicle; C, Cauda of alate female. D, Cauda of larva.

Cornicles long and cylindrical, jet black, reticulate at the apex. Cauda black, long, hairy, when fully extended fully half the length of the cornicles.

Legs yellowish, with black areas at the apex of the femora and tibiae, and black tarsi.

Insertions, cubitus and costa of wings yellowish; stigma grey.

Length.—2.7 to 3 mm. *Wing expanse*, 8 to 8.5 mm.

[1] Mon. Pflanzenlause, 60, 1843, Kaltenbach.
[2] Pflanzenlause, 1857.

Apterous viviparous female.—Various shades of deep red and reddish-brown. Antennae with the two first and the last segments dark, rest reddish and paler, third segment with about twenty-seven sensoria on its basal half, and some rather long hairs, also on the basal segments. Long hairs on the head and body, on the latter arising from brown tubercles.

Legs yellow, black on the apices of the femora and tibiae, and the tarsi black, with long stiff hairs. Cornicles long, cylindrical, black, reticulate at the apex, rest imbricated. Cauda black or deep reddish-black, long.

Length.—3 mm.

Localities.—Wye (14/6/11); New Romney (6/8/12); Tynemouth, Devon (8/8/09); Worcester (10/8/09); Shalford, Surrey (7/8/84); Sidmouth, Devon (8/85).

Food Plants.—*Solidago virgaurea; Scabiosa?; Centaurea cyanus* and other *Compositae* (Schouteden).

Notes.—Kaltenbach refers to this species as occurring on the Golden Rod (*Solidago virgaurea*) from August to October. Buckton that it forms large clusters on the flower stalks of that plant. I have found it on that plant and also in numbers on wild Scabious. Whilst the young apterae have always a *black*, blunt, short cauda, some of the females had it reddish-black, and when freshly moulted pale red. I have taken both alate and apterous forms together in June, and found it to continue until October. No sexupara have been found, but they probably occur in October and oviposit on those plants named.

5. **Macrosiphum sonchi** (Linn.).

Aphis sonchi, Linnaeus.
Siphonophora achilleae, Koch.
Siphonophora sonchi, Passerini and Buckton.
Siphonophora lactucae, Koch (not Fabricius).
Aphis serratulae, Linnaeus. ?
Siphonophora alliariae, Koch. ?

Syst. Nat., II, 735, 15, Linnaeus; Sp. Ins., II, p. 390, 48; Mant. Ins., II, p. 317, 53; Ent. Syst., IV, p. 220, 53; Syst. Rhyn., p. 302, 53. Fabricius; Fn. Boica, II, p. 120, 1232, Schrank; Fn. Etrusc., p. 265, 1402, Rossi; Mono. Pflanz., I, p. 28, Kaltenbach; Ann. Nat. Hist., Ser. 2, Vol. II, p. 197, 46, and Zool., VI, pp. 2246-2248 (part), Walker; Die Pflanz., p. 160, figs. 217, 218, *219*, Koch (*alliariae*); p. 159, figs. 215, 216 (*achillae*), Koch; Mono. Brit. Aph., I, p. 161, pl. xxviii, Buckton.

Alate viviparous female.—Head and thorax deep black, more or less shiny; abdomen rich shiny chestnut to reddish-brown, with three black spots on each side before the cornicles and one behind

them, from which arise hairs from small tubercles (seen as small, pale spots in balsam preparations), a dark patch at the base of the cornicles, and an elongate black patch between these two. Antennae long and black, arising from large frontal tubercles; the third segment with sensoria along the whole of its length, between 48 and 55 in number, hairs slightly expanded at their apices, the fifth segment very slightly shorter than the fourth. Cornicles very long, thin, black, the apices with large irregular hexagonal reticulations. Cauda pale, long, with numerous hairs. Legs yellowish to yellowish-brown, a broad black area on the apex of the femora, one

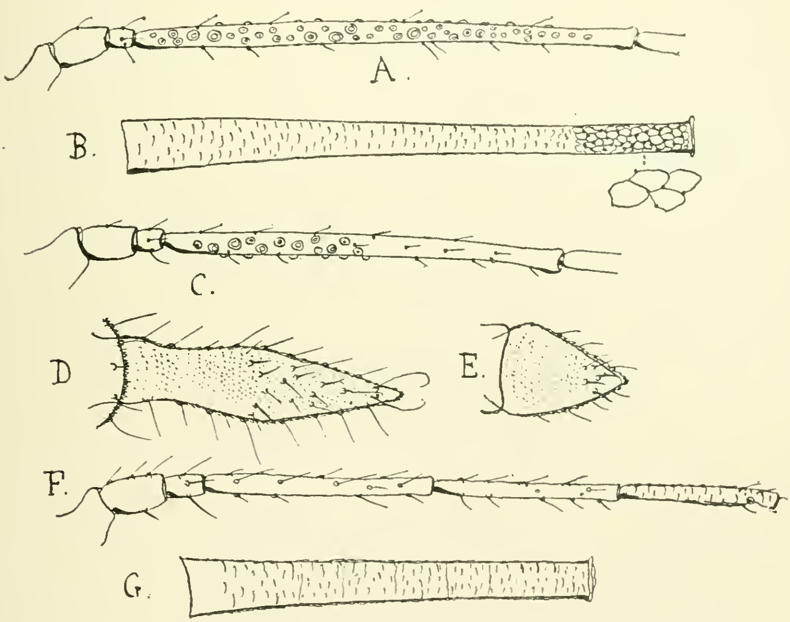

Fig. 6.—*Macrosiphum sonchi* (Linn.).
A, Antenna; B, Cornicle; D, Cauda of alate female. C, Antenna of apterous female. E, Cauda; F, Antenna; G, Cornicle of larva.

on the tibiae smaller in size, tarsi black; hairs short, pale. Wings with yellow insertions, and pale yellowish-brown stigma and veins.

Length.—2.5 to 3 mm. *Wing expanse*, 8 to 8.5 mm.

Apterous viviparous female.—Rich chestnut-brown to deep reddish-brown, shiny. Antennae long, arising from very large frontal tubercles, black to pale brown; third segment a little longer than the fourth, with 17 to 20 sensoria on the basal half; hairs acuminate; fifth segment shorter than the fourth. Abdomen with rows of hairs arising from tubercles. Cornicles long, black, thin, with

reticulate sculpturing at the apex. Cauda elongate and yellow. Legs long and thin and ochreous, apex of femora and base and apex of tibiae black; tarsi black; the tibiae, which are very long, have short hairs.

Length.—2.5 to 3 mm.

Localities.—Common all over Britain and the Continent.

Food Plants.—*Sonchus oleraceus, Centaurea nigra* and cultivated varieties, *Serratula arvensis. Chrysanthemum segetum* and cultivated *Chrysanthemums, Lapsana communis, Carduus,* spp. Buckton also gives *Picris hieracoides, Hieracium sylvestre, Crepis biennis* and *Carduus mutans.* I have also found it on lettuces.

Notes.—This species is very marked. It has been recorded by Walker as being almost omniverous, no less than thirty food plants being given. I think, however, that Walker refers to more than *two* species.

Koch describes a *Siphonophora lactucae,* Fabricius, which is clearly this species. He found it on *Lactuca perennis.* Kaltenbach considered it also to be *sonchi,* but Buckton disagrees with this. It is subject to some variation according to the plant it is found on, but the structural characters are all similar in those found on the different plants mentioned. The very bristly cauda is characteristic.

6. **Macrosiphum sisymbrii** (Buckton).

Siphonophora sisymbrii, Buckton.

Mono. Brit. Aph., I, p. 160, pl. xxvii, figs. 4 and 5.

Taken at Pembroke in August on the Hedge Mustard or Rocket (*Sisymbrium officinale*).

It is said by Buckton to resemble *M. sonchi,* but differs in having the tarsi all black, a smooth abdomen, and by the presence of three large obscure spots on the abdominal edges. Ventrally it is all green, except a black anal patch and black coxae.

The *apterous female* is rich ochreous-brown, very shining; head, thorax and abdomen divided by a bright ochreous band; lower part of abdomen and lateral edges ochreous. Body covered by small black tufted tubercles. Tail long and yellow. Cornicles black. Legs black, except for yellow femoral bases.

Length.—2.54 mm.

Alate viviparous female.—Colour much as in the apterous female; abdomen not tuberculate. Antennae very long.

Length.—2.54 mm. *Wing expanse,* 8.63 mm.

I have been unable to find this species.

7. **Macrosiphum jaceae** (Linn.).

Aphis jaceae, Linnaeus.
Siphonophora jaceae, Koch.
Aphis cardui, Boyer.
Aphis cirsii, Gmelin.
Aphis sonchi, Walker (part).

Fauna. Suec., 991; Syst. Nat., I, II, 735, n. 20, Linnaeus; Fn. Boic., II, 124, n. 1244, Schrank; Ent. Carn., 138, n. 403. Scopoli; Mono. Pflanz., 26, Kaltenbach; Die Pflanz., 162, figs. 220, 221, Koch; Mono. Brit. Aph., I, 153. pl. xxiii. figs. 3 and 4, Buckton; Ed. Syst. Nat., I, 4, 2206, 20, Gmelin; List. Hom., 963, 54, Walker; Mono. Brit. Aph., I, 153, pl. xxiii, figs. 3. 4. Buckton; Aphid. Belg., 239, 12, Schouteden; Aphid. Lig., 58, 18, Ferrari; Aphid. Ital., 11 and 15, n. 15, Passerini.

Alate viviparous female.—Shiny brown, with metallic sheen; hairy. Antennae long, about as long as the body or longer, the third segment with many sensoria, longer than the fourth, the fourth longer than the fifth, the sixth nearly as long as the fourth and fifth

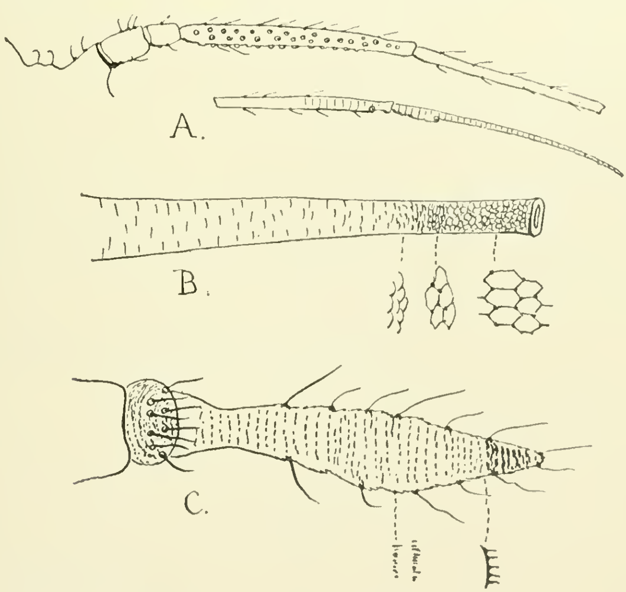

Fig. 7.—*Macrosiphum jaceae* (Linn.).
Alate female. A, Antenna; B, Cornicle; C, Cauda.

together; the first segment large, arising from a large frontal process; black. Legs black, except the base of the femora; cauda long, thin, black. Cornicles, long, narrow, black, the apex reticulate, remainder imbricated. Wings with yellowish cubitus, stigma and base.

Length.—3.5 to 4 mm.

Apterous viviparous female.—Dark brown, with greenish to brassy lustre. Antennae dark, the first segment large, the third longer than the fourth, with sensoria on basal half, the fourth longer

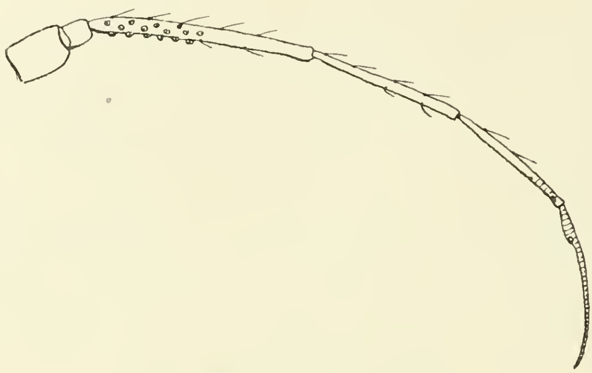

Fig. 8.—*Macrosiphum jaceae* (Linn.).
Antenna of apterous female.

than the fifth, the sixth not quite as long as the fourth and fifth. Abdomen with tufts of bristles laterally, arising from tubercles. Cauda black, long and narrow. Cornicles black, long and thin, reticulate at the apex, imbricated below. Legs as in the former.

Length.—2.5 to 3 mm.

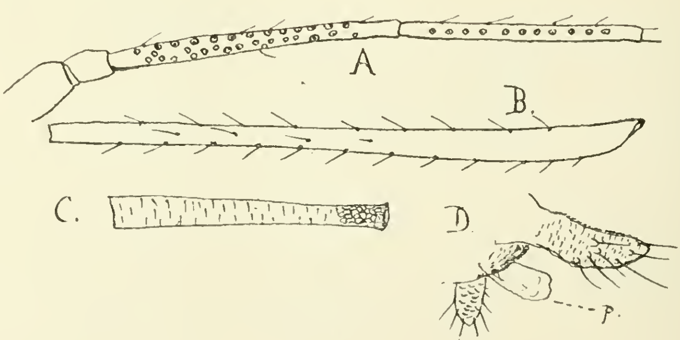

Fig. 9.—*Macrosiphum jaceae* (Linn.).
Male. A, Antenna; B, Hind tibia; C, Cornicle; D, Cauda and penis.

Male.—Winged; the cubitus, stigma and base yellowish-brown, veins the same colour. Antennae with about fifty sensoria on the third segment, fourteen to sixteen on the fourth segment. Cornicles

thin, long and black, reticulate at apex, imbricated below; cauda and cone shaped process below penis dark; penis yellow, blunt.

Length.—2 mm.

Oviparous female.—Apterous; similar in colour to the viviparous form. Antennae as long or longer than the body, the third segment with sensoria on its basal two-thirds, the fourth shorter than

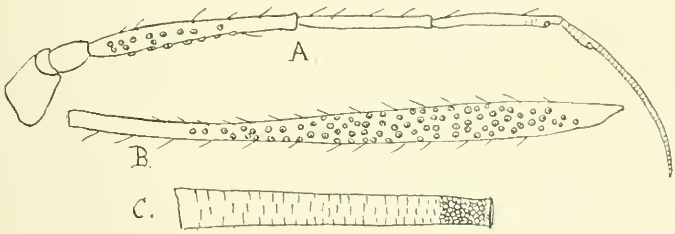

Fig. 10.—*Macrosiphum jaceae* (Linn.).
Oviparous female. A, Antenna; B, Hind tibia; C, Cornicle.

the third, the fifth a little shorter than the fourth, sixth about as long as the fourth and fifth. Cornicles ornamented as in other forms. Hind tibiae very long and with numerous sensoria up to nearly the apex.

Length.—2 to 2.5 mm.

Food Plants.—*Centaurea nigra; Centaurea cyanus; Centaurea nigrescens* (Kaltenbach); *Alsine* (Schouteden); *Ruta graveolenti* (Ferrari); *Scabiosa; Carduus nutans; C. acanthoides,* and *C. crispus* (Kaltenbach); *Sonchus oleraceus* (Buckton).

Localities.—Wye, Crundal, Herne Bay, Faversham, Bearsted, Swanley, Tenterden, in Kent; Kingston-on-Thames, Esher, Godalming, Egham, Weybridge (Theobald), Haslemere (Buckton), Woking, in Surrey; Cambridge; Hastings, Rye, Eastbourne, Hailsham, Colemans Hatch, Tunbridge Wells, Sussex; Ventnor, Isle of Wight; New Forest, Corfe, Weymouth in Dorset (Theobald).

Life Cycle.—The ova are laid on the Knapweed in October and into November. Some fall to the ground, others remain on the dead seed-heads.

They hatch in late April, and apterae occur until July, when alate viviparous females appear. The first of these I took on July 2nd, in 1906. These fly to other Centaureas and Sciobosae, and reproduce in a similar manner. In October sexuparae occur, often in numbers, but the winged males evidently are rare. The oviparous females look just like the viviparous apterae, clustering in dense masses up the flower heads and on the stalks. The larvae differ in

having the cornicles entirely imbricated, shorter and thicker, and in having no antennal sensoria.

8. **Macrosiphum muralis** (Buckton).

Siphonophora muralis, Buckton.

Mono. Brit. Aph., I, p. 157, pl. xxvi.

Described by Buckton from specimens found at Weycombe, Haslemere, feeding on the flower stalks of *Lactuca muralis* in the first week in July.

It resembles *sonchi*, but the legs and antennae of the apterae are longer, and the tubercles less marked. Brown in colour, cornicles and antennae dark; cauda pale, half the length of the cornicles; four black spots at the side of the body.

The alate female has dark brown head and thorax, abdomen garnet red (not shown this colour in the figure). Antennae and cornicles long and black. Cauda yellow and long. Legs pale yellow, with dark apices to the segments, and dark tarsi.

The male is winged very small (1.01 mm. long), uniformly umber brown; legs and cornicles ochreous, with dark femoral and tibial points.

Oviparous females cinnamon brown, apterous, very small. It is strange that the sexuparae should be found in July. Probably they are a distinct species, and not a Macrosiphum at all.

9. **Macrosiphum absinthii** (Linn.).

Aphis absinthii, Linnaeus.
Siphonophora absinthii, Koch, Passerini, Buckton.
Aphis balsamitae, Muller.

Syst. Nat., II, p. 735, 19, Linnaeus; Fn. Suec., p. 991, Linnaeus; Ent. Syst., IV, p. 214, 20; Syst. Rhyn, p. 297, 20; Mant. Ins., II, p. 315, 19, Fabricius; Ent. Carn., p. 137, 401, Scopoli; Zool. Dan. Prod., 1270, Muller; Handb. Ent., II, p 95, 4, Burmeister; Mono. Pflanz., p. 31, 19, Kaltenbach; Ann. Nat. Hist., Ser. 2, II, p. 202, 48, Walker; Die Pflanz., p. 198, 34, figs. 271, 272, Koch; Mono. Brit. Aph., I, p. 154, pl. xxiv, figs. 1 and 2, Buckton.

Apterous viviparous female.—Dark brown, some with a reddish-brown hue with dark lateral spots, pilose, and more or less covered with white meal, in some a dark central spot. Antennae deep brown, arising from small frontal tubercles, longer than the body, third segment longer than the fourth, fourth and fifth nearly equal, sixth short, not quite as long as the fourth and fifth together, on the third segment are 35 to 40 sensoria on the basal half. Hairs on the head yellowish, those on the body arising from dark tubercles and

rather long. Proboscis dark brown, reaching to beyond the third coxae. Legs deep brown, femora very thick, femora and tibiae with stiff dark hairs, especially numerous on the hind tibiae. Cauda

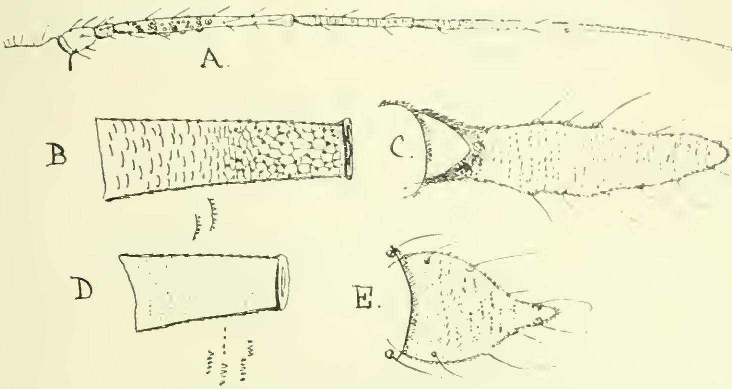

Fig. 11.—*Macrosiphum absinthii* (Linn.).
Apterous female. A, Antenna; B, Cornicle; C, Cauda. D, Cornicle and E, Cauda of larva.

black, as long as the cornicles. Cornicles black, thick, slightly tapering to the apex, apical half reticulate, rest imbricated. Eyes deep red.

Length.—2 to 3 mm.

Alate viviparous female.—I have never found this. Kaltenbach describes it as being black, shiny, the abdomen brown spotted as in the apterous female. Wings whitish, with a brownish-yellow costa.

Koch figures the female.

Localities.—Hereford (Durham); Tenby (Theobald); Wanstead (Walker).

Food Plants.—*Artemisia absinthia, A. abrotana.*

Notes.—Found in July and August. Those sent me by Dr. Durham from Hereford were taken on July 27th, 1911; those from Tenby I found in August. This species appears to be uncommon. When fresh, their white mealy coat is very marked, and the dark areas show up plainly against it. I do not think Buckton's *absinthii* is correctly named.

10. **Macrosiphum artemisiae** (Boyer) (non Koch).

Aphis artemisiae, Boyer.
Aphis tenacetaria, Kaltenbach.

Ann. Ent. Soc. Fr., T.x, p. 162, Boyer de Fonscolomb. (1841). Mono. Pflanz., p. 19, Kaltenbach (1843): Die Pflanz., p. 187, figs. 257, 258, Koch. Ann. d. Mus. Civ. d. Stor., Nat. d. Genova, II, p. 53 and 111, p. 212, Ferrari.

Apterous viviparous female.—Green to deep green; head and proboscis deep brown; antennae as long as the body, black, third segment longer than the fourth, the fourth longer than the fifth, the sixth not quite as long as four and five, the segments with rather large pale hairs, many slightly capitate, basal half of the third with sensoria; frontal lobes large, with several large hairs, some of which may be capitate. Cornicles black, rather short, expanded at the base,

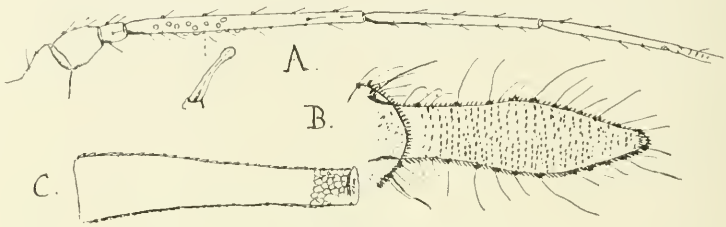

Fig. 12.—*Macrosiphum artemisiae* (Boyer).
Apterous female. A, Antenna; B, Cauda; C, Cornicle.

reticulate on the apical portion. Cauda black, as long as the cornicles, with many long golden lateral hairs and several dorsal ones. Legs black and thick, femora pale just at the base, femora with a few, tibiae with dense, spine-like golden hairs. Abdomen with short, scattered hairs, arising from small pale tubercles, last segment brown; the hairs all over the body and legs may be slightly capitate. Eyes red.

Length.—3 to 4 mm.

Alate viviparous females.—Black, abdomen bright green to grass green, somewhat mealy and indented; antennae and legs black, femora dull greenish. Head brown. Eyes reddish-brown. Proboscis reaches to the second pair of legs, apex dark brown, first segment greenish-yellow, vertex and neck ring green, with a dark tinge. Thorax black; scutellum green to black. Abdomen grass green, traces of lateral dusky spots in some specimens. Cornicles black, rather thin, moderately long, scarcely thickened at the base. Cauda black, thick, as long as the cornicles. Legs black, base of the femora greenish. Wings shiny, insertions and costa yellowish, stigma greyish, veins brownish.

Length.—2.5 mm.

Locality.—Great Lalkeld, Penrith, Cumberland (Britten).

Food Plants.—*Tanacetum vulgare, Artemisia vulgaris* and *A. absinthia; Leucanthenio vulgari* (Ferrari), *Achillea millefolium* Schouteden).

Notes.—I have only seen the apterae which Mr. Britten collected in numbers on the Tansy. It is a very marked large species.

The antennae are so black I have been unable to clear them sufficiently to see the accurate arrangement of the sensoria. Boyer de Fonscolomb described this insect as *artemisiae*, so that Koch's name must sink, Ferrari renaming his species *kochii* (p. 212).

11. Macrosiphum lilacina (Ferrari).

Siphonophora lilacina, Ferrari.

Species Aphid. Liguriae. Ann. d. Mus. Civ. d. Stor. N. d. Genova, p. 216, 1872.

This aphid bears a general resemblance to the other species found on the Tansy (*Tanacetum vulgare*), but can at once be told by its dark, almost black, caudal process.

Wingless viviparous female.—Rosy to brick-dust red; head and front of thorax black. Antennae black, longer than the body. Legs dark. The antennae have the third segment with eight sensoria on the basal half in line on one side; the fourth segment is about two-thirds the length of the third, the fifth is shorter than the fourth,

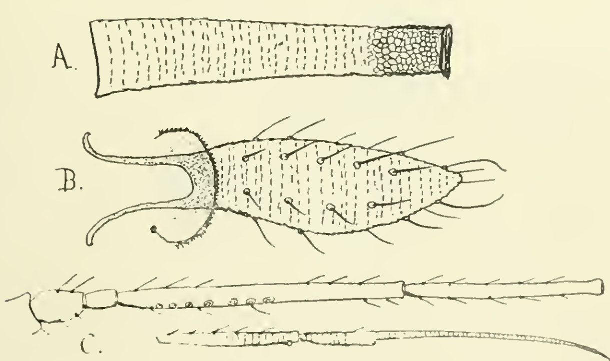

Fig. 13.—*Macrosiphum lilacina* (Ferrari).
Apterous female. A, Cornicle; B, Cauda; C, Antenna.

and imbricated towards the apex; first, third, fourth and fifth segments with hairs. Cornicles thick, with irregular hexagonal reticulation on the apical third, the rest imbricated. The cauda is swollen in the middle and moderately long, with four pairs of chaetae on its surface and a medial apical one, two pairs of prominent lateral ones on the basal portion, and others as shown in the figure. There are some dark spots on the abdomen.

Locality.—Hereford (24/7/1911), (Dr. Durham).

Notes.—Ferrari described this species from Serravalle and Staz-

zano about the blossoms of *Tanacetum vulgare* on September 29th, 1872.

Only apterous forms were sent me.

12. **Macrosiphum tanaceticolum** (Kaltenbach).

Aphis tanaceticola, Kaltenbach.
Siphonophora tanaceticola, Passerini and Buckton.

Mono. Pflanz., p. 33, Kaltenbach; Mono. Brit. Aph., I, p. 159, pl. xxvii, figs. 1 and 2, Buckton.

Found by Walker on the Tansy (*Tanacetum vulgare*) in May at Abingdon.

The apterous female only known, but Buckton obtained pupae. It is bright garnet red and shiny, carinated and ringed. Cornicles black. Cauda yellow. Legs reddish-yellow; tarsi black. Antennae long, yellow and hairy, as are the legs.

Length.—1.89 mm.

Kaltenbach found his specimens in September and October.

13. **Macrosiphum tanaceti** (Linn.).

Aphis tanaceti, Linnaeus.
Siphonophora tanaceti, Koch and Buckton.

Syst. Nat., II, p. 735, 18, Linnaeus; Mono. Pflanz., p. 47, Kaltenbach; Die Pflanz., p. 156, figs. 211, 212, Koch; Mono. Brit. Aph., I, p. 151, pl. xxiii, Buckton. Ent. Syst., IV, p. 217, n. 36, Fabricius; Fn. Boica., II, p. 123, n. 1241, Schrank.

Buckton records this insect from *Lapsana communis*, in June, with no locality. It may not be Linnaeus' species, and differs widely from Kaltenbach's fuller description of Linnaeus' *tanaceti*, in which the body is dark green, marked with black.

Walker records it in apterous form from the Isle of Wight, taken in September on Tansy (*Tanacetum vulgare*). As I have been unable to find this species, and searched for it in the Island, I make no further comments, as Walker considered it to be synonymous with *absinthii* (List. Hom. Ins. Brit. Mus. Pt. iv, p. 965, 56, 1852). Kaltenbach records it from *Tanacetum vulgare*, June to September.

14. **Macrosiphum millefolii** (Fabricius).

Aphis millefolii, Fabricius.
Siphonophora millefolii, Koch, Buckton.

Ent. Syst., IV, p. 214, n. 17, Fabricius; Fn. Boica, II, p. 123, n. 1243, Schrank; Mono. Pflanz., p. 10, Kaltenbach; Die Pflanz., p. 182, fig. 249, 250, Koch; Mono. Brit. Aph., I, p. 127, pl. xii, Buckton.

Alate viviparous female.—Head, band on pronotum and thoracic lobes black; abdomen, front and sides of thorax and band between

head and pronotum green; the abdomen with a darker green median line and small black transverse dots, four or five large black lateral spots, three or four smaller ones above them.

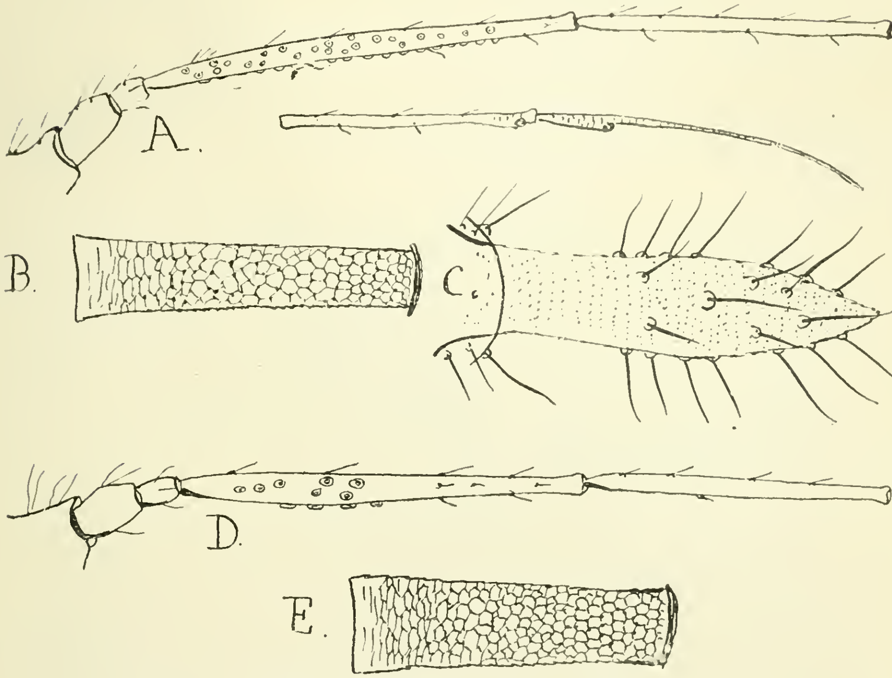

Fig. 14.—*Macrosiphum millefolii* (Fabr.).
Alate female. A, Antenna; B, Cornicle; C, Cauda. Apterous female. D, Antenna; E, Cornicle.

Antennae blackish-green, darkened at the apices of the segments and at the tip, the third segment with sensoria along nearly the whole length.

Eyes bright red. Cornicles black, reticulate from the apex down to two-thirds or more of the length nearly; straight. Legs long, dark; femora yellowish, except at the apex, tibiae dark green, dusky at the apex, tarsi dark; hairy. Cauda long, black, with long hairs. Body with tufts of fine hairs.

Wings with yellowish-green insertions, stigma yellowish-grey, veins dark greenish.

Length.—2.5 to 2.8 mm. *Wing expanse*, 6.8 to 7 mm.

Apterous viviparous female.—Green to greenish-yellow, head paler than the rest of the body; prothorax black; mesothorax with black markings. Abdomen with tufts of hairs and with rows of black spots and other scattered ones; cauda long, black, nearly as long as the cornicles. Anal band, black. Antennae black, longer than

the body, the third segment with eleven to twelve sensoria on the basal half. Legs long, black; femora of first and second pairs yellowish, with long hairs. Cornicles black, moderately long, reticulate over most of the surface, in some a dark crescent-shaped mark at their base.

Length.—2.5 to 3 mm.

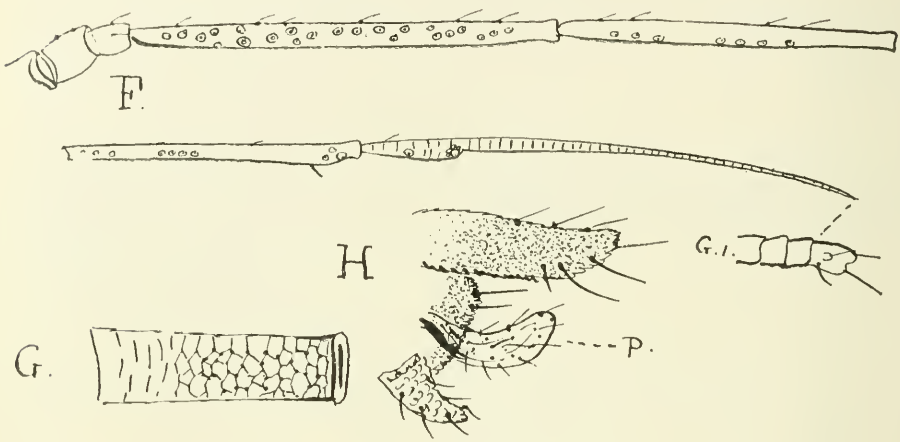

Fig. 15.—*Macrosiphum millefolii* (Fabr.).
Male. F, Antenna; G, Cornicle, H, Cauda; G1, Apex of antenna; P, Penis.

Male.—Winged. Thorax, prothorax, cornicles dark brown; abdomen deep rusty-red to almost orange, with three to four irregular dark transverse bars and some rows of spots; three large dark spots on each side. Antennae dark brown, much longer than the body, the third segment with twenty-two to twenty-four sensoria, the fourth with seven in a line, the fifth with two or three near the base, four in the middle, two towards the apex, and three sub-apical ones; one at the base of the sixth, below the usual group. Cauda dark; penis pale, curved upwards.

Cornicles black, short and rather thick, marked with large irregular hexagonal sculpturing over two-thirds of their surface.

Length.—1.2 to 1.5 mm. *Wing expanse*, 6 mm.

Oviparous female.—Apterous. Antennae simple, the third, fourth and fifth segments nearly equal, the third somewhat swollen; head and body hairy. Legs with long hairs, especially on the long, broad hind tibiae, which show no sensoria. Cornicles black, short and broad, expanding basally, imbricated. Cauda black, triangular, about as long as the cornicles.

Length.—1.5 to 2 mm.

Localities.—Wye, Kent; Great Staughton, Hunts; Great Lalkeld, Penrith; Hereford; Sidmouth, Teignmouth, Lynton, Exeter,

Devon; Worcester; Esher, Kingston, Guildford, Shalford, Kenley, Surrey; Filey, Luddenden Foot, Yorkshire; Buxton and Millers Dale, Derby (Theobald); Haslemere (Buckton).

Food Plants.—*Achillea millefolium, A. ptarmica,* and *Pyretheum,* sp. ? (Schouteden).

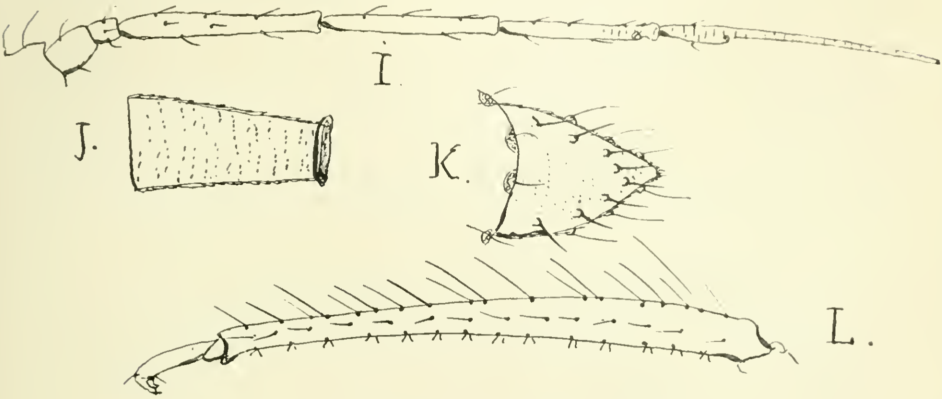

Fig. 16.—*Macrosiphum millefolii* (Fabr.).
Oviparous female. I, Antenna; J, Cornicle; K, Cauda; L. Hind tibia.

Life-Cycle.—The ova are laid on the seed-heads of the yarrow and other food plants, the sexuparae appearing in October and November. The young occur in May, and remain in small numbers until July, when they often increase at a great rate, and from then onwards winged viviparous females occur. Dates on which I noticed winged broods are July 20th, August 7th and 22nd, September and October continuously.

The winged males with their small bodies occur side by side with the apterous oviparous females and alate viviparous forms. One male appears only to fertilize a single female and then dies. They remain in copula a considerable time, and are almost impossible to separate.

15. **Macrosiphum taraxaci** (Kaltenbach).

Aphis taraxaci, Kaltenbach.

Mono. Pflanz., p. 30.

Alate viviparous female.—Head and thorax brownish-black to black. Antennae black, as long as the body; the third segment with many sensoria along most of its surface, the fourth shorter than the third, the fifth shorter than the fourth, the sixth not as long as the fourth and fifth together. Abdomen reddish-brown, with short hairs,

which arise from dark tubercles. Cauda black, short. Cornicles long, black, cylindrical, the apex reticulate, rest markedly imbricated. Legs dark, except the base of the femora, which are yellow; femora, tibiae and tarsi hairy, hairs yellow. Wings shiny, with yellowish stigma and cubitus and yellowish-brown veins, in some almost yellow.

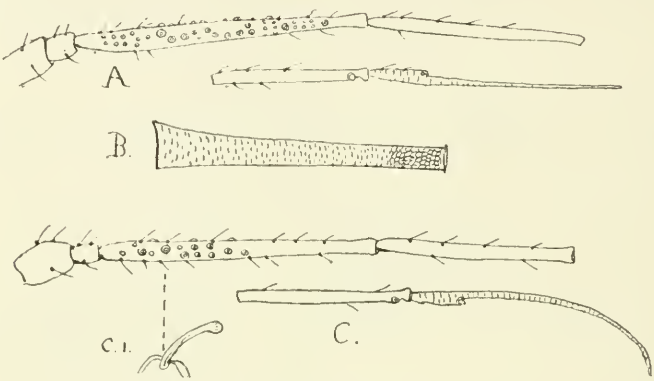

Fig. 17.—*Macrosiphum taraxaci* (Kalt.).

A, Antenna and B, Cornicle of alate female. C, Antenna of apterous female; C1, Antennal hair.

Length.—2.5 to 2.8 mm. *Wing expanse*, 9 mm.

Apterous viviparous female.—Coffee-brown; head and thorax somewhat darker than the abdomen, with a slight metallic sheen. Antennae, cornicles and cauda black. Legs black, except the bases of the femora, which are reddish-yellow.

The third segment of the antennae has sixteen to twenty sensoria on its basal half, the fourth segment shorter than the third, and the fifth a little shorter than the fourth, the sixth not so long as the fourth and fifth together; hairs on the third to fifth yellowish.

The cornicles have a large apical reticulate area, remainder imbricated. The abdominal hairs spring from dark tubercles. Some of the antennal hairs are slightly capitate, this is more marked in some specimens than in others.

Length.—2.8 to 3 mm.

Localities.—Great Lalkeld, Penrith, Cumberland (14/6/12). Taken by Mr. Britten, and Wye (17/6/11).

Food plant.—The Dandelion (*Leontodon taraxacum*).

Notes.—I know of no record of this species in Britain. Schouteden records it from Belgium (p. 240) on *Taraxacum officinale*. Neither Koch nor Ferrari refer to it. It is found in apterous form

under the lower leaves, and sometimes penetrates to the parts just below ground. The alate females occur on the leaves and on the flower stalks.

16. **Macrosiphum olivatum** (Buckton).

Siphonophora olivata, Buckton.

Mono. Brit. Aph., I, p. 164, pl. xxix, figs. 344 (1875).

Apterous viviparous female.—Deep olive brown to rich brown, with minute dark tubercles, from which arise hairs. Antennae longer than the body, the first and second and last three segments deep olive, third yellowish; the third with a group of thirty or more unequal-sized sensoria on the basal half, where there are many hairs

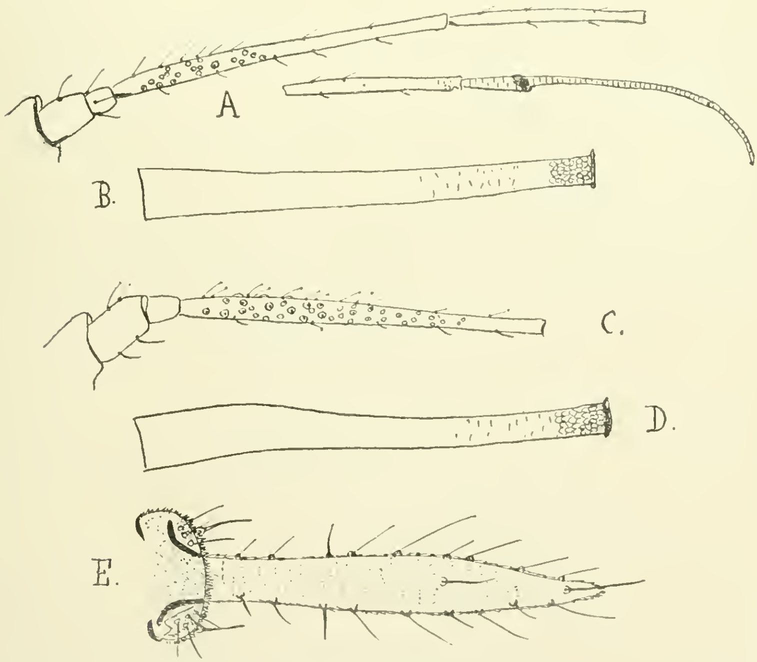

Fig. 18.—*Macrosiphum olivatum* (Buckton).
A, Antenna, and B, Cornicle of apterous female. C, Antenna, D, Cornicle, and E, Cauda of alate female.

on one side, three beyond and five on the other side, fourth and fifth segments nearly equal. Cornicles long, straight, rather narrow, black, reticulate at the apex, remainder partly imbricated. Cauda rather long and pointed, black at the apex, paler at the base. Hairs on the posterior region of the abdomen minutely capitate, also on

the head. Legs long, rich ochreous, with broad black areas at the apex of the femora and tibiae and black tarsi, hairy. Proboscis ochreous, last two segments black.

Length.—3 mm.

Alate viviparous female.—Head and thorax black. Abdomen deep reddish-brown, with four black lateral spots and black tubercles, from which arise hairs, some of the posterior hairs minutely capitate, as are those on the frontal lobes.

Antennae long, deep olive green, base of the third segment paler, the latter has numerous sensoria on its whole length, except just at the apex, and the hairs capitate. Cornicles shiny black, long, thin, expanded at the base and slighly curved, reticulate at the apex. Cauda long, narrow, pointed, yellowish, with a marked single dorsal spine near the apex and one towards the middle. Legs as in the apterous female. Wings large, yellowish-green stigma and insertions.

Length.—2.8 to 3.2 mm.

The larva has no antennal sensoria, and the cornicles no apical reticulation.

Localities.—Wye (7 and 29/6/11); Ventnor (28/4/12); Lynchmere, Sussex (8) (Buckton). Haddenham, Cambridgeshire (19/6/11).

Food plants.—*Carduus lanceolatus* and other species of thistles.

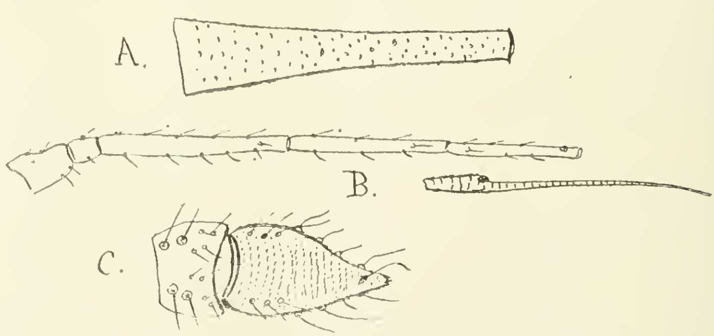

Fig. 19.—*Macrosiphum olivatum* (Buckton).
Larva. A, Cornicle; B, Antenna; C. Cauda.

Notes.—Buckton, who described this species, says that the cauda of the apterous female is black. Those I have found have a black cauda in the larvae, but the mature apterae have it pale at the base and much longer than in the larvae, in one or two in one colony it was almost entirely pale.

It lives in large colonies clustered up the flower stalks of the thistles, especially on those growing near water. It is largely attended

by ants. The alate forms occurred in July and August. It is quite distinct from Walker's *carduina*, which Buckton places with a query under this species; Walker's species is green, and is apparently also a *Macrosiphum*.

17. Macrosiphum campanulae (Kaltenbach).

Aphis campanulae, Kaltenbach.
Siphonophora campanulae, Koch.

Mono. Pflanz., p. 26, Kaltenbach; Die Pflanz., p. 164, figs. 224, 225, Koch.

Apterous viviparous female.—Reddish-brown, shiny, slender; cornicles long, and with the equally long cauda, black. Legs black, the base of the femora yellow.

Length.—2 to 2.5 mm.

Alate viviparous female.—Shiny black, abdomen reddish-brown, wings whitish, veins very thin; insertions and costa whitish-yellow. Antennae, proboscis, legs (except base) and cornicles black.

Length.—2 mm. to 2.5 mm.

Locality.—Ashford Warren, Kent (20/5/11).

Food plant.—*Campanula rotundifolia; Chrysanthemum* (Schouteden).

Notes.—I have only seen this species once in Britain, Mr. Jemmett sending me a number of young forms clustering up the flower stalks of the Hairbell.

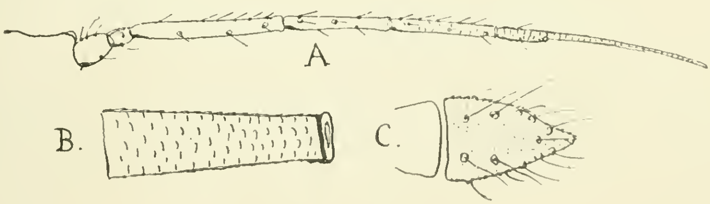

Fig. 20.—*Macrosiphum campanulae* (Kalt.).
Larva. A, Antenna; B, Cornicle; C, Cauda.

Buckton placed this as a synonym of *sonchi*. It is quite distinct as far as I can see from the larvae. Schouteden also considers it a distinct species.

Kaltenbach records it in June and July.

The larvae are reddish-brown with dark antennae, cornicles and short cauda, legs dark except the base of the femora, and rather short and thick, femora and tibiae hairy, especially the latter. Proboscis dark, reaching to the second coxae, and thick towards the tip. The antennae, which are as long as the body, are hairy, the third segment

longer than the fourth, the sixth a little longer than four and five together; in very young forms the third is no longer than the fourth. The abdomen has small hairs arising from dark tubercles. The rather short, thick, black cornicles are imbricated.

18. **Macrosiphum luteum** (Buckton).

Siphonophora lutea, Buckton.

Mon. Brit. Aph., I, p. 119, pl. viii.

Described from specimens from Orchidaceae from hothouses at Carshalton, Surrey, found in January.

The *apterous female* is bright yellow or yellowish-green, with a dark brown spot on the dorsum; black antennae, with pale reddish first and second segments. Cornicles black, stout. Cauda long and green. Femora green, dark at the apex, tibiae and tarsi brown. The *alate female* is yellow or pale yellowish-green. Antennae dark, long. Cornicles long, black and shiny, bases dilated. Cauda yellow. Abdomen with two rows of obscure dots at the sides.

Schouteden has since found this species on *Cypripediums* and other Orchids in the Botanical Gardens in Brussels.

19. **Macrosiphum lactucae** (Schrank).

Aphis lactucae, Schrank.
Aphis ribicola, Kaltenbach.
Siphonophora ribicola, Koch.
Siphonophora lactucae, Buckton, Passerini (nec Koch).
Aphis ribis, Frisch.

Fn. Boica, II, p. 120, n. 1233, Schrank; Mono. Pflanz., p. 33, Kaltenbach; Die Pflanz., p. 195, figs. 267, 268, Koch; Ent. Syst., IV, p. 211, n, 7, Fabricius; Ins., XI, p. 9, t. 14, Frisch; Syst. Nat., I, II, p. 733, n. 1, Linnaeus; Gli. Aphidi, p. 34, Passerini; Mono. Brit. Aph., I, p. 139, pl. xvi, Buckton; Journ. Econ. Biol., vii, pt. 3, p. 102, pl. iii, fig. 1, Theobald.

Alate viviparous female.—(On Ribes). Thorax shining black, a green line on each side, spreading out posteriorly; pronotum green, with two black spots. Head green, darkened in front, stemmata dark; eyes dark red to black; antennae dark, longer than the body, third segment with 30 to 40 sensoria spreading over its whole length, fourth segment with 7 to 14 sensoria, mainly along one side, faintly striate, some hairs slightly capitate. Abdomen shiny green to yellowish-green, second, third and fourth segments with two dark basal patches, fifth and sixth each with two small patches closer together; in some there are dark marks further back; three large black lateral spots and traces of a fourth one basally. Cornicles long,

thin, cylindrical, black, often paler at apex, which is reticulate, rest imbricated; cauda dark brown, moderately long, blunt. Wings with yellowish-brown to brown stigma. Legs green to yellowish-green, apical half of femora, apex of tibiae and the tarsi dark; femora and tibiae bristly.

Length.—2 to 2.5 mm. *Wing expanse,* 7.5 mm.

Apterous viviparous female (on Ribes).—Green, shiny. Eyes red. Antennae green, apices of fourth and fifth segments dusky, sixth dusky, especially at base and apex.

Abdomen with five to seven slightly darker lateral spots. Cornicles long, yellow, slightly dusky at the apex, which is reticulate, rest faintly imbricated. Legs yellowish-green, tarsi dark.

Length.—2 to 2.5 mm.

Apterous viviparous female.—(On Lettuce). Yellowish-green to bright green. Abdomen with seven pairs of dark lateral spots, wrinkled and shiny. Antennae longer than body, the third segment with 20 to 25 sensoria, most numerous on basal half; basal segment dusky, second, third, fourth and fifth pale green, apices of third to fifth dusky; sixth segment dusky, but paler in the middle, hairs minutely capitate. Some capitate hairs also on the body, and several on the head. Cauda yellowish. Cornicles yellowish, dusky at the apex, which is reticulate, rest faintly imbricated.

Legs yellowish-green to green, apices of femora dusky, a broad, dark apical band on the tibiae, and dark tarsi.

Alate viviparous female.—(On Lettuce). Head and thorax dark brown to black, shiny. Eyes dark red. Antennae dark brown, longer than body; third segment with 22 to 39 sensoria spreading over nearly the whole surface, fourth segment with 11 to 14 sensoria; hairs slightly capitate.

Abdomen green, with five to seven irregular, dark, broken bands and four large, dark lateral spots; apex and cauda dusky. Cornicles dark brown, pale and reticulate apically, rest imbricated, long.

Legs ochre-yellow, apical half of femora, apex of tibiae and the tarsi dusky. Wings with yellow insertions and brown stigma.

Length.—2.5 mm.

Localities.—Wye, Paddock Wood, Yalding, Tunbridge Wells, Chelsfield, Swanley, Bearsted, in Kent; Worthing, Colemans Hatch, Hastings, in Sussex; Cambridge; Great Lalkeld, Penrith, Cumberland; Great Staughton, Hunts.; Widdington, Essex; Ventnor, Isle of Wight; Fowey and Truro, Cornwall; Exeter, Lynton, Budleigh, Devon.

Food plants.—Lettuce and Endives (*Lactuca*), Sow-thistle (*Sonchus oleraceus*), *Crepis viridis*, and all varieties of *Ribes*.

Notes.—An abundant species, often very harmful to Lettuce and Currants. It occurs on the currants up to June, and a few may be found in the first week in July. It then flies off to lettuces, endives, sow-thistles and *Crepis*, and feeds until the autumn, when it flies back to the currants, and there the sexuparae are produced. Buckton (Pl. xvi, fig. *f*) shows the alate female of *lactucae* with black cornicles; but in his description says, "Cornicles green, with black tip"; this is not correct. Buckton also mentions pink varieties amongst the apterous viviparous females, and the pupae as being green, brown or pink, the pink varieties often having a green dorsal band and faint lateral stripes. Now and then I have found these variations on the lettuce, but never on the currants. Kaltenbach refers to *ribicola* as occurring on the mountain currant in May, and later on *Crepis viridis*. In the nymphs there is no reticulation on the cornicles, and the tips of the wing cases are dusky, and the antennae paler.

20. **Macrosiphum kaltenbachii** (Schouteden).

Siphonophora alliariae, Koch.

Die Pflanz., p. 177, figs. 243, 244 (not p. 160, figs. 217-219), Koch; Mono. Brit. Aph., I, p. 123, pl. x, figs. 4-6, Buckton; Aphid. Belg., p. 237, Schouteden.

Alate viviparous female.—Green to dark green; head, band on the pronotum and thoracic lobes black. Antennae longer than the body, dark brown to black, paler at the base of the third segment, which has forty or more sensoria extending over nearly the whole length of the segment, fourth segment shorter than the third, with six to nine sensoria mostly on one side, fifth slightly shorter than the fourth, sixth long and thin, with a very small, swollen basal region, the whole segment considerably longer than the fourth and fifth, last three segments strongly imbricated. Eyes black. The green abdomen has four irregular, broken, black transverse bands, sometimes represented by four pairs of transversely elongated lateral spots, three large black spots on each side, a large dark patch behind each cornicle, and other dark marks (bars and spots) behind. Hairs arise from small black tubercles. Cauda black. Cornicles black, thin cylindrical, and moderately long, the apex with a few transverse lines and cross-lines, remainder imbricated.

Legs yellowish, femora and tibiae with broad, dark apical bands, and dark tarsi, tibiae with many fine, short hairs. Wings with yel-

low insertions and cubitus, and yellowish-grey to grey stigma. Proboscis in some reaching the third pair of legs, in others the second pair.

Length.—2.2 to 2.5 mm. *Wing expanse*, 6 mm.

Apterous viviparous female.—Green, somewhat shiny. Antennae as long or a little longer than the body, dusky at the apices of the segments and around the sensoria on the sixth, flagellum of sixth pale brown; the third segment has two to four sensoria near the base, and short, slightly capitate, hairs; the fourth shorter than the third,

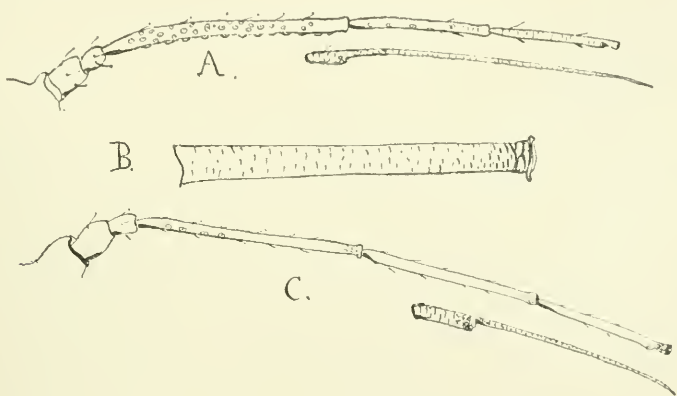

Fig. 21.—*Macrosiphum kaltenbachii* (Schou.).
A, Antenna, and B, Cornicle of alate female. C, Antenna of apterous female.

the fifth shorter than the fourth, the sixth not quite as long as the fourth and fifth together. Cornicles long, thin and cylindrical, expanded at the base, a few large reticulations at the apex, remainder imbricated; cauda long, pale yellowish-green. Legs yellowish, with dark apex to the tibiae, and dark tarsi; small pale hairs on the tibiae.

Length.—2.5 to 3 mm.

Localities.—Wye (22/5/12) and (2 to 7/6/13); Cambridge (7/6/94); Sidmouth (4/6/09); Corfe (2/5/11); Rudgwick, Sussex (5/6/13). Brussels (Schouteden).

Food plants.—*Lapsana communis* (Buckton); *Alliaria officinalis; Sonchus macrophyllus* (Schouteden).

Notes.—Found in abundance in both stages in May on Garlic Mustard (*Alliaria officinalis*), under the leaves. Buckton records it as numerous in early June under the leaves of the Nipple Wort.

Koch described two *alliariae* on p. 160, figs. 217, 218 and 219, the present species on page 177, the former having priority. Schouteden proposed the name *kaltenbachii* for the second.

I am inclined to fancy that the *alliariae* on page 160 is the same as Buckton's *olivata*. The alate form of *kaltenbachii* is very marked. The apterous female is obscure, and there is some variation in the number of sensoria on segment three of the antennae. Buckton figures the cornicles of the apterae as black (pl. x), but in the text he describes them as green. He also says the rostrum of the alate female is rather short; if anything, it is rather long.

I have only found this species on *Alliaria officinalis,* unless two apterae I have from *Cichorium intybum* are the same.

21. **Macrosiphum hieracii** (Kaltenbach).

Aphis hieracii, Kaltenbach.
Siphonophora hieracii, Buckton and Koch.

Mono. Pflanz., p. 17, Kaltenbach; Mono. Brit. Aph., I, p. 126, pl. xi, Buckton; Die Pflanz., p. 152, figs. 206, 207, Koch; Aphid. Belg., p. 239, Schouteden.

Alate viviparous female.—Head and thorax black, a green band between the head and pronotum and the pronotum and mesothorax.

Abdomen green, of various shades, with five interrupted black bands and traces of a sixth and black lateral spots. Cauda dusky-green. Antennae black, as long or longer than the body, base of the third segment pale, third segment with twenty-four to thirty-four

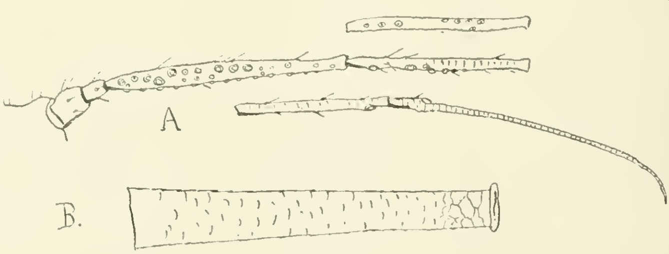

Fig. 22.—*Macrosiphum hieracii* (Kalt.).
Alate female. A, Antenna; B, Cornicle.

sensoria extending to the end of the segment, fourth segment with four to six sensoria on its basal half, sixth with a small basal enlargement, fourth, fifth and sixth imbricated, hairs simple and scanty.

Eyes reddish-brown. Cornicles blackish-brown, moderately long, cylindrical, but in some expanding at the base, just at the apex, large reticulations, remainder imbricated.

Legs green, the apices of the femora, tibiae and the tarsi black, femora and tibiae with short hairs.

Proboscis dark at the apex. Wings with greenish-brown veins, brown stigma, and yellowish-green insertions.

Length.—2.2 to 2.5 mm.

Apterous viviparous female.—Green, shiny; blackish-brown on the head, thorax and abdomen, except for bands on the thorax and posterior region of the abdomen. Antennae as long or longer than

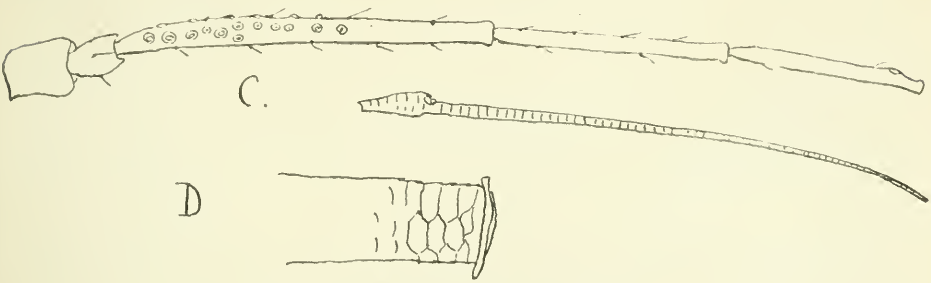

Fig. 23.—*Macrosiphum hieracii* (Kalt.).
Apterous female. C, Antenna; D, Apex of cornicle.

the body, somewhat hairy, brown; the third, fourth and fifth segments paler except at their apices, the third is somewhat swollen basally, and has eleven to fifteen sensoria on its basal half, a few extending to near the apex; some of the hairs slightly capitate.

Cornicles short and dusky in young forms, pale and longer in the mature. Legs yellowish, with the apices of the tibiae and tarsi

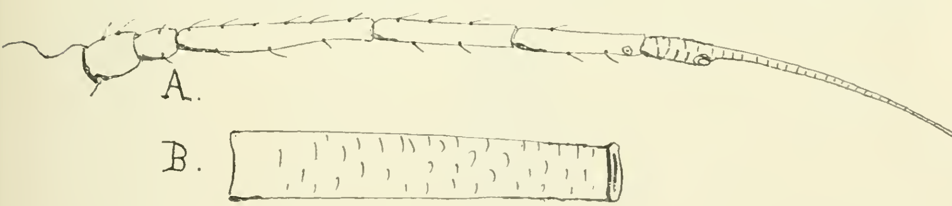

Fig. 24.—*Macrosiphum hieracii* (Kalt.).
Nymph. A, Antenna; B, Cornicle.

brown, some with brown apices to the femora, and some with the legs mostly pale brown.

Length.—2.2 mm.

Localities.—Great Lalkeld, Penrith, Cumberland (Britten); Niton, Isle of Wight (2/5/11); New Forest, Hampshire (4/5/12); Wye, Kent (7/6/10; 17/6/12; 19/8 and 20/9/12). Schouteden records it from Belgium.

Food plants.—*Hieracium sylvestre, H. murorum*, and cultivated *Hieracium* and *H. pilosellae* (Schouteden).

Notes.—This species is one of two common ones on wild, but especially common on cultivated, *Hieraciums* I have found in Kent. It is subject to some variation in colour and markings, Kaltenbach speaking of red varieties having bristly tubercles on the back. The latter I have not seen, but many apterae assume a dull reddish appearance.

The figures given by Buckton (Pl. xi) do not accurately represent this insect, as the winged viviparous female never seems to have actual black bars on the abdomen, and the cornicles are not greyish-green, as described in the text, or green, as shown in the figure, but brownish, as originally described by Kaltenbach, some being deep brown.

It especially clusters up the flower stalks, but may also be found on the leaves, and even on the blossoms. In one cultivated *Hieracium*, in which the hair-glands secrete much sticky matter, these aphides thrive and assume the coloration of the plant tissue in the apterous form. I have never found sexuparae. Buckton describes two *hieracii*, Kaltenbach, one a Siphonophora, and the other an Aphis.

22. **Macrosiphum duffieldii**, n. sp.

Alate viviparous female.—Head dark brown; antennae dark brown, a small, pale yellowish-green band at the base of the third

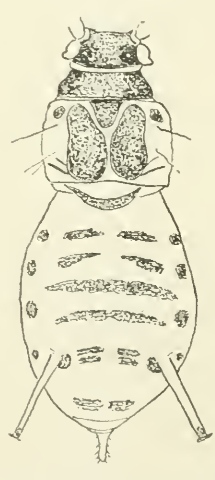

Fig. 25.—*Macrosiphum duffieldii*, n. sp.
Body markings of alate female

segment, and a small pale area at the junction with the head; as long as the body; the third segment has nine to ten sensoria close together in one row, and three wider apart nearer the apex; the hairs are short, thick and blunt. Eyes black. Prothorax dark brown, a narrow green band separating it from the head; mesothorax with dark brown median lobes, green at the sides and in front; metathorax dark in the middle.

Abdomen pale apple-green; with two pairs of long black spots basally, almost forming bands, then two irregular black bands, then

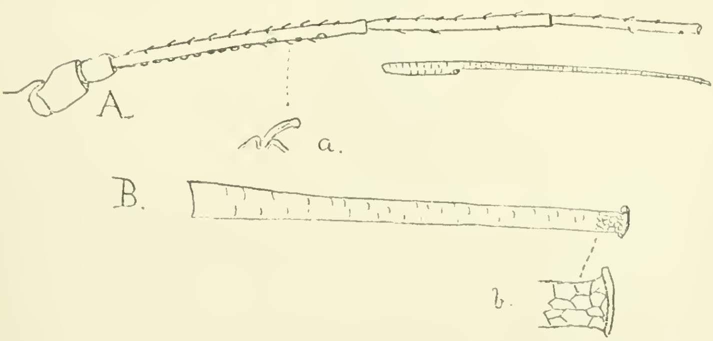

Fig. 26.—*Macrosiphum duffieldii*, n. sp.
Alate female. A, Antenna; a, Hair of antenna; B, Cornicle; b, Apex of cornicle.

four median black spots, and one at the base of each cornicle and two nearer the cauda; three or four pairs of black lateral spots; cauda green.

Cornicles long and thin, green with black apices, the apices reticulate, rest imbricated.

Legs green, apices of femora and tibiae deep brown.

Wing veins pale brown.

Ventrally the thorax is mainly plain apple-green, darker than the dorsum.

Length.—2.5 to 3 mm.

Apterous viviparous female.—Head pale fawn colour to pallid ochre; eyes black; antennae pale brown, apices of segments 3 and 4 black; last segment dark, a single sensorium at the base of segment three. Thorax and abdomen pale apple-green, becoming darker posteriorly; at the base of the cornicles a large yellow area; cauda pale yellowish-green; cornicles pale yellowish-green with dark apices. Legs very pale brown, with jet-black tips to the femora and tibiae, and black tarsi.

Locality.—Maidstone, Kent (27/3/13), on Tulips in a nursery.

Notes.—In considerable quantity, and causing no little harm to the leaves. Found both on and under the leaves, and some on the flower stalks. The alate females received on the 27th of March commenced to produce living young on April 3rd, and by the 7th quite

Fig. 27.—*Macrosiphum duffieldii*, n. sp.
Antenna of apterous female.

large colonies existed. By the end of the week the alate females seemed restless, however, as if wishing to migrate. They reproduced on the tulips, however, and a fresh brood of alate females commenced to arise on April 22nd, and on a new tulip being planted they at once settled on it, and continued reproducing in numbers.

The hairs on the antennae are marked, being sunk in pits, and short, thick, and somewhat expanded apically, giving a quasi-clavate appearance. The only *Macrosiphum* described from tulips is *Siphonophora tulipae*, Monell., from America. It cannot be this species, from the description, which is as follows:—

"Apterous females: Pale green, with a dusky-green stripe down the middle, and darker green on the margins of the abdomen, Winged individuals with the antennae as long as, or a very little longer than, the body, mounted on conspicuous tubercles which are not erect, apical joint long and thread-like, longer than the fifth, and about five times as long as the sixth. Honey tubes very long, dusky at apex. Tail when extended about twice as long as the tarsi, pale green. Length, 3.04 mm. On petals and stigma of Tulips. April, Saint Louis, Mo."

From this description one must assume the alate form is green;[1] whilst the one described here has marked adornment.

Two other aphides occur on Tulips, namely, *Aphis rumicis*, Fabricius, which I have recently received from Newark, and *Aphis tulipa*, Boyer.

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[1] Bulletin of the U.S. Geological and Geographical Survey of the Territories, 1879, vol. v, no. 1, p. 19.

23. **Macrosiphum primulae**, n. sp.

Alate viviparous female.—Head brown; eyes black; antennae brown; a small pale area at the base of the third segment; about as long as the body. The third segment of the antennae with 35 to 40 sensoria along nearly all its length. Prothorax brown; mesothorax

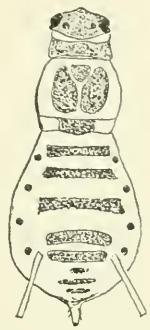

Fig. 28.—*Macrosiphum primulae*, n. sp.
Body markings of alate female.

yellowish-green, with two brown lateral lobes, a small median brown one in front; dark brown areas at the sides; metathorax brown in the middle; head and prothorax pale beneath, rest of thorax black beneath.

Abdomen apple-green to pale yellow-green, with three transverse dark bands, and two following being often more or less fused at the sides, followed by a small median dark spot and traces of other

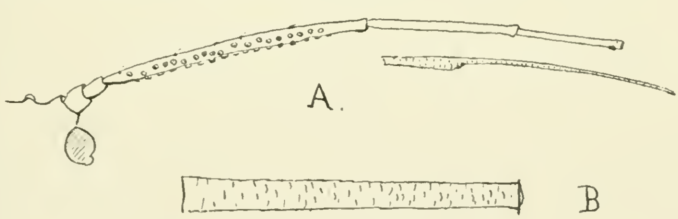

Fig. 29.—*Macrosiphum primulae*, n. sp.
Alate female.—A, Antenna; B, Cornicle.

markings; three pairs of dark lateral spots and a dark spot near the base of the cornicles; cauda pale brown to yellowish-green, also the cornicles, which are faintly imbricated. Legs yellowish-green, with black tarsi. Wings with grey stigma and pale greyish veins.

Length.—2.5 mm.

Apterous viviparous female.—Shiny, almost white or pale yellowish to yellowish-green, with black eyes and small black tips to the cornicles, and dusky tarsi; most with black specks on the body.

One specimen dusky-brown, with dark apices to femora and tibiae. In the forms out of doors some were rich green and marmorated, and the tips of the tibiae were dusky. Antennae with dusky apices to the segments and a dusky apex. One specimen was green, with darker antennae, and pale brown legs, with dusky tarsi.

Length.—2.2 to 2.5 mm.

Locality.—Maidstone, Kent (27/3/13); Stouting, near Hythe, Kent (28/4/13), (Duffield).

Food plants.—*Primula kewensis* and *P. vulgaris.*

Notes.—Found on *Primula kewensis* in numbers in a nursery. The dark form is evidently the same species. They are very active in the apterous stages, when removed from their food plant. I transferred a number of apterae on the 29th to a potted *Polyanthus*, and by the 3rd they had settled down, and by the 7th four females had started colonies under the leaves—one colony numbering over twenty. They seem to prefer the dark, and all collected on the lower leaves away from the light of the laboratory window. By the 21st another brood of alate females appeared. Later Mr. Duffield found this species on the Primrose out of doors.

24. **Macrosiphum aquilegiae,** n. sp.

Alate viviparous female.—Head, thorax and abdomen apple-green to yellowish-green, with brown markings as follows—two large median patches on the thorax, a small one in front, and another small one behind; abdomen with four pairs of long, transverse, lateral dark lines, and below each a dark spot.

Antennae longer than the whole body, dark, first, second and base of third segments pale green. The third segment a little longer than the fourth, with a line of eleven to twelve sensoria, fourth segment slightly longer than the fifth, sixth about as long as the fourth and fifth together.

Legs yellowish-green, with dark apices to the femora and tibiae, and the tarsi dark. Cornicles long and thin, yellowish-green, with dark apices, large reticulations at apex, rest strongly imbricated. Cauda pale yellowish-green. On the venter of the thorax is a large dark median plate.

Length.—2.5 mm.

Apterous viviparous female.—Green to citron yellow; some specimens show paler mottlings posteriorly, others darker green mottling in the middle, and some a paler line along each side. Antennae pale yellowish-green, black at apex, and showing two or three narrow black bands, a single sensorium on the third segment.

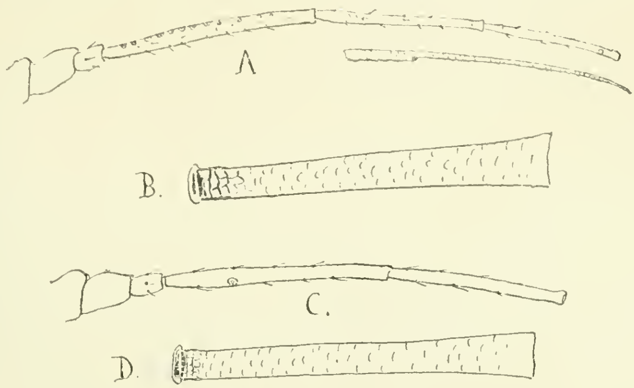

Fig. 30.– *Macrosiphum aquilegiae*, n. sp.
A, Antenna, and B. Cornicle of alate viviparous female. C, Antenna, and D, Cornicle of apterous female.

Legs pale yellowish to pale green, apices of tibiae and the tarsi black, some specimens show a black spot at the apices of the femora. Cornicles pallid, with small dark apices, reticulate just at apex, rest imbricated. Cauda pale green.

Some show dark abdominal spots similar to the winged female.

Length.—2 mm.

Nymph.—Yellowish-green, with a median dark thoracic spot; abdomen with similar markings to the winged female. Wing buds pale olive-green, darker than the body. Legs with dark tarsi and apices to the tibiae. Cauda darkened.

Localities.—Chandlers Ford, New Forest (24/4/1912); Wye (24/3/1912, and 17/6/1912); and Stouting, near Hythe, Kent (28/4/13). Taken by Mr. Adrian Duffield. Little Hadham, Herts (27/5/13), (Theobald).

Food plant.—On wild Columbines in the New Forest, and on garden Aquilegias at Wye, Stouting, and Little Hadham.

25. **Macrosiphum veronicae**, n. sp.

Alate viviparous female.—Head and thorax pale yellowish-brown, the former paler than the thorax, black stemmata; eyes very

dark red; antennae dark brown, first and second segments same colour as the head, longer than the whole body.

Abdomen rather swollen, bright, shiny apple-green. Cornicles long, thin, green, with black apices. Cauda ensiform, green. Legs pale greenish-brown, except the apex of the femora, tibiae and tarsi, which are black. Proboscis green, dark at the apex, not quite reaching to the second coxae.

Traces of three dark areas on the thorax of a brownish tint, one in front, and the others on the two lateral lobes.

Wings normal; stigma grey.

Apterous viviparous female.—Pale brownish-green, somewhat shiny, head paler than the body. Antennae longer than the body, pale at the base, darkened towards the apices. Legs pale, slightly dusky at the apex of the femora, black at the apex of the tibiae and on the tarsi. Cornicles long, thin, pale, apices dark. Cauda knob-shaped, green, about half the length of the cornicles. Skin wrinkled. Eyes black. Hairs on head and basal segments of the antennae slightly capitate. Legs hairy, some of the hairs minutely capitate. Body nude except at the apex.

The young are green, shiny, legs dusky to pale green at the base; hairs on the head capitate. Skin shiny and wrinkled as in the adult; antennae dark, except the two basal segments, which are deep greenish-brown.

Locality.—Wye (22/5/1912).

Food plant.—*Veronica beccabunga.*

Notes.—The winged female was very sluggish, the apterous ones active. The single mature apterous female had produced many young. All were feeding amongst the flower heads. I could only find this single colony in a large mass of this plant growing near the river Stour, and the description is drawn up from living specimens.

NOTES ON THE OCCURRENCE OF THE WOOLLY APHIS, *SCHIZONEURA LANIGERA*, IN THE CORE OF APPLES.

By

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Royal College of Science, Dublin.

With 1 Figure.

On January 20th I received for examination the core of an apple, which I found to be infected with the Woolly Aphis, *Schizoneura lanigera*. The apple had been bought from a Dublin fruit dealer, who stated it was a "Newtown Pippin" from California, and part of a consignment sold to him in the Dublin fruit market. Four more of the apples were purchased from the same dealer, and two of the same variety from another dealer in the same locality. All these fruits were infected with the aphid. In three of the seven apples examined the aphids were alive, in the other four they were dead, the dead aphids being easily found.

The apples externally did not appear to be infected, except for a little mildewy appearance of the eye, but on being cut in two through the core the aphids were easily seen. There is a small channel connecting the eye with the core in these apples (see figure), and through this channel the aphids gained access to the core; this channel, however, is not common in many varieties.

The core presented a white mouldy appearance, due to the woolly secretion of the aphids. In the apples in which the aphids were dead the cores were mouldy, due to the growth of some fungus, which was probably secondary. The damage done to the core was very slight, as the aphids did not appear to have pierced through the carpels. In one apple, which was rather more badly infected than the others, the seeds presented a damaged appearance, but the flesh of the apple was not injured in any instance.

The Woolly Aphids in general live in two situations; some are found underground, attacking and causing abnormal growths on the roots, while others are found infesting and causing that cottony appearance on the branches that is due to colonies of this insect. In the aerial forms wingless males and females are produced from winged parthenogenetic females; the occurrence of these sexual

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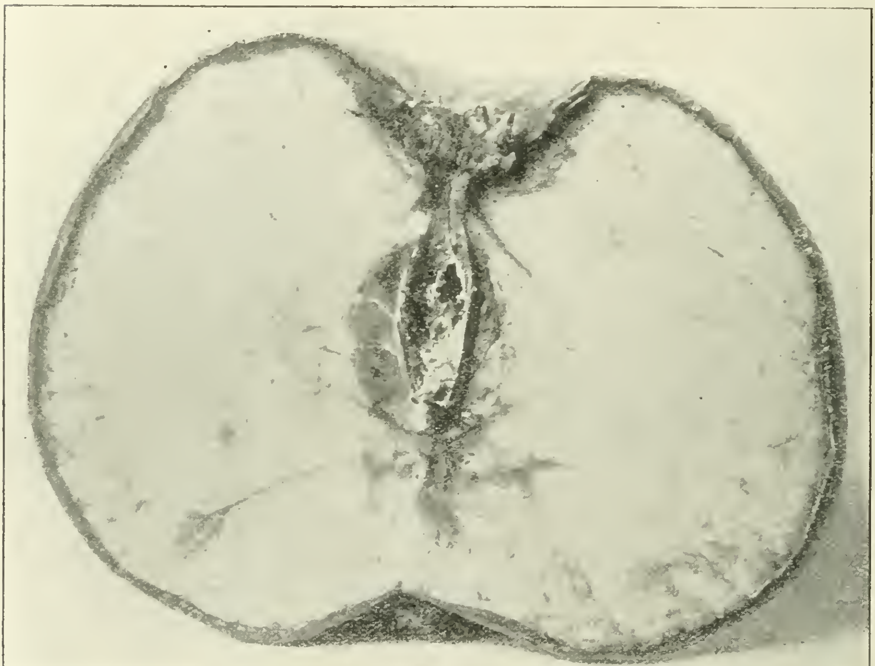
forms, however, is rare, and the generations of the species are carried on mainly by parthenogenetic females, which hibernate on the roots or in the cracks or under the bark of the stems during the winter months, producing in spring a fresh generation of parthenogenetic females. The latter form was the one found in the apples, adult females and larvae in the different stages of development being present. Only one or two adults were found in each core, the others being immature forms.



Newtown Pippin Apple cut in median section to show channel from eye to core, which is invaded by *Schizoneura lanigera*.

According to C. L. Marlatt,[1] growth and reproduction would appear to be suspended during hibernation. F. V. Theobald[2] however, states that he has known "successive broods continue right through the winter."

This occurrence in the fruits, although doing the apples very little damage is, when considered, seen to be of considerable economic importance. The importation of the apples infected in this way

[1] U. S. Dept. Agric., Entom. Circular No. 20.

[2] Insect Pests of Fruit. Wye, 1909 (p. 147).

with Woolly Aphid, and their subsequent distribution for consumption, affords the aphid an opportunity of gaining an entrance and establishing itself in fresh orchards in this country. Of course the chance of such introduction is not very great, but there is a possibility that uneaten infected cores might find their way in manure, or when thrown away, into orchards; once the aphid becomes established in an orchard it is exceedingly hard to eradicate.

This occurrence of Schizoneura in the apple core is not mentioned in any literature on the subject of the Woolly Aphid to which I have access, nor can I find a record of its attacking the fruit in any way. Its occurrence in this manner is probably more common than is known, and seems to be not only a convenient method of hibernation, possibly enabling the species to propagate itself during the winter, but a means of spreading the pest from one country or district to another.

Another possible means of hibernation has just been shown us by Miss Edith M. Patch,[1] who has proved in America that *Schizoneura americana* of the elm and *S. lanigera* of the apple are identical. She claims that, like Chermes, which has spruce for its normal host, and another species of conifer for its intermediate host, the Schizoneura of the apple is only a migrant from the elm, which is the normal host-plant of the sexual brood, the eggs being hidden in crevices in the elm bark during the winter months. These eggs develop into virgin "stem-mothers," which give birth to a second generation of wingless females. The offspring of these are the third spring generation, which acquire wings and migrate from the elm (according to Miss Patch's observations) in spring and during the summer months, to give rise on the apple to colonies of nymphs, which are identical with *S. lanigera*. The return migration to the elm, she states to take place in Autumn, but she has not yet from observation linked it with the sexes on the elm.

The sexual brood, however, has been observed to occur on the apple. J. M. Stedman[2] states that on the apple trees in breeding cages, late in the fall, males and females were produced; after pairing, the females each laid a single egg and perished.

C. L. Marlatt[3] states, on the authority of Messrs. Howard and Pergande, that the winged autumn forms are the parents of the sexual insects, the females of which deposit a single "winter egg" in a

[1] Bull. No. 203. Maine Agric. Exp. Stat.

[2] Bull. No. 35. Agric. Exp. Stat., Columbia, Missouri.

[3] Circ. No. 20, Revised Ed. U. S. Dept. Agric.

crevice of the apple bark. F. V. Theobald,[1] however, states that the occurrence of the sexual brood is rare. He says: "Twice in twelve years it has occurred on one tree constantly kept under observation." He further states that the egg is found close to the base of the apple tree above ground, the egg remaining hidden in a crevice in the bark during winter. H. W. Lohrenz[2] obtained from isolated winged Schizoneura from the apple, which he kept in tubes, male and females; after mating the female deposited her egg and perished; this, however, affords no information as to the normal host.

From the above evidence it would appear that the occurrence of the sexual brood on the apple is uncommon, and as there seems to be a doubt as to the European *S. ulmi* being identical with *S. americana* it would be interesting to know if there is any genetic relation between the two species, *S. ulmi* of the elm, and *S. lanigera* of the apple, in this country, and also if the migration which is known to take place in summer from the apple is to the elm instead of always to other apple trees, as is generally believed.

The question is one of great importance to gardeners and fruit-growers in this country where the pest is prevalent, and much valuable information could doubtless be obtained by further observations on the habits of this most harmful pest.

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[1] Insect Pests of Fruit. Wye, 1909, p. 147.

[2] Journ Econ. Entom., 1911, vol, 4, pp. 162-170.

COLLEMBOLA DAMAGING PINE TREES.

By

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I HAVE shown in a previous communication to this Journal[1] that quite a large number of species of Collembola are injurious to various species of roots and flowering plants, and also that they act as carriers of the spores of fungi.[2] Not until quite recently, however, have I found them injurious to forest trees, nor do I know any recorded instance of such.

Some short time ago a correspondent submitted to me a number of shoots of *Pinus sylvestris*, the opening buds of which were commencing to fall away. The young needles had a dry, withered appearance in some cases, but still retained their connection with the shoot, whilst in others they immediately fell away on being handled.

On dissecting out a few partially damaged buds I found a number of specimens of a Collembolan, and on further investigation every damaged bud was found to contain five or six examples.

The species turns out to be referable to *Seira nigromaculata*, Lubbock, which identification has been kindly confirmed by Professor Geo. H. Carpenter.

The nature of the damage is as follows: the insect seems to be attracted by the resinous gum, and, as soon as the leaf bud opens, makes its way to the bases of the young leaves and commences to bite into the same; after a short time the needles turn yellow and ultimately fall away. Sometimes only part of the base is destroyed, and part of the bud remains in a damaged condition, but in most cases the new buds are completely ruined.

Preventive measures, such as the scattering of napthaline around the base of the stem, or smearing it with some sticky material in the autumn, would probably keep the trees free from these insects.

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[1] Journ. Econ. Biology, 1909, vol. iv, pp. 83-86; also Journ. Land Agents' Soc., 1911, vol. 10 pp. 259-274.

[2] Journ. Econ. Entom., 1910, vol. 3, pp. 204, 205.

REVIEWS.

Auld, S. J. M., and D. R. Edwardes-Ker.—Practical Agricultural Chemistry. Pp. xxiv + 243, 32 figs. London: John Murray. 1913. Price, 6s. net.

A text-book on agricultural chemistry must be largely a manual on bio-chemistry. Most authors make the mistake in such works of writing a handbook on chemistry, in which there is here and there some slight reference to agricultural problems, whilst others, excepting that they make some slight reference to the chemical constituents of soils and plants, do not markedly differ from the ordinary chemical text-book.

The authors of the present work have had a long experience in the training of agricultural students, and we expected a work evincing some of the practical character which has been so conspicuous in their actual teaching, and we find it.

The work is divided into six sections, dealing respectively with plant life; soils; fertilisers and manures; feeding stuffs; dairy products; and the examination of waters and soap.

Wherever one turns we find the salient points of each experiment briefly recalled, and emphasis laid on the qualitative side of the subject. The experiments are well planned, lucidly described, and stamped with a finish that the earnest student will highly appreciate. In short, this work is one of the best we have seen, and must for some time to come be regarded as a standard, where real practical knowledge is desired as the outcome of careful study.

Brunetti, E.—The Fauna of British India. Diptera Nematocera (excluding *Chironomidae* and *Culicidae*). Pp. xxx + 581, 12 plts. and 44 figs. London: Taylor and Francis, 1912.

The study of Oriental Diptera, Mr. Brunetti informs us, is yet quite in its infancy, less than 3,000 species being known from the whole region so late as 1896. The *Culicidae* is the only family that has been extensively studied from any considerable number of localities.

Over four hundred species are dealt with in the present volume, of which two hundred and fifty are new, and excepting about sixty, all have been described by the author.

An able and lucid introduction describes the external anatomy of a fly; the early stages of Diptera; on the collecting, classification of Diptera, and other matters of general interest.

In addition to the actual descriptions of species, the author gives us very careful descriptions of the genera, keys to the same and the species. Here and there we find notes on the life-history, figures and descriptions of the larvae, genitalia, etc. Many of these are extracted from the writings of other workers, whose names are appended.

The work has been so thoroughly and carefully carried out, that we hope the author will have further volumes to add to what must be regarded as a very valuable contribution to our knowledge of Oriental Diptera.

Henderson, L. J.—The Fitness of the Environment. Pp. xv + 317. New York: The Macmillan Company, 1913. Price, 6s. 6d. net.

The thesis which the present volume seeks to establish, so we are informed in the preface is as follows: "Darwinian fitness is compounded of a mutual relationship between the organism and the environment. Of this, fitness of environment is quite as essential a component as the fitness which arises in the process of organic evolution; and in fundamental characteristics the actual environment is the fittest possible abode of life."

Whilst there is much of interest to the biologist, there is much of a hypothetical and controversial nature. Regarding the subject from the standpoint of the biologist, the author has scarcely done justice to it, the chemical and physical aspects being given undue prominence, in a word, there is an absence of correlation.

Jardine, N. K.—The Dictionary of Entomology. Pp. ix + 259. London: West, Newman and Co. 1913.

If Mr. Jardine's work induces entomologists to be more exact in their descriptions and writings generally, it will have served a most useful purpose, but its chief sphere of usefulness lies in the opportunity it gives beginners of knowing the exact meaning of the terms they employ or those employed by others, and it is to such we most strongly recommend it as a valuable addition to their bookshelves.

Knipe, H. R.—Evolution in the Past. Pp. xv + 242, 56 plts. and 7 text figs. London: Herbert and Daniel, 1912. Price, 12s. 6d. net.

The author vividly portrays the fauna and flora of the various geological ages, describing the same in an interesting though non-technical language. The drawings of Miss Alice B. Woodward are

specially interesting, and in themselves form a useful record. The introduction of the various restorations given by Marsh, Zittel, and others might very well have been worked into the book as text figures.

Lundbeck, W.—Diptera Danica. Pt. IV. Dolichopodidae. Pp. 416 and 130 figs. Copenhagen: G. E. C. Gad, 1912.

The fourth part of this excellent work treats of the *Dolichopodidae*, which are described under four sub-families and thirty-five genera.

About 586 species are known from the palaearctic region, and 526 from North America. But little attention has been paid to the developmental stages or biology, and the larvae and pupae of only a few genera have been described. Professor Lundbeck describes for the first time the pupae of *Hygroceleuthus*, *Tachytrechus* and *Hercostomus*.

A very full description is given of the family and the same thoroughness is devoted to both genera and species as has characterised the earlier parts of this work.

The four parts now issued extend over a thousand pages of letterpress, illustrated by 340 figures, and the work has already taken its place as one of the principal monographs on the subject. It is a most helpful and valuable work.

Newman, L. W., and H. A. Leeds.—Text Book of British Butterflies and Moths. Pp. 216. St. Albans: Gibbs and Bamforth, Ltd., 1913. Price, 3s. 6d. net.

Lepidopterists will find this handbook exceedingly useful, for it contains a mass of valuable information in a readily accessible form. Thus we have first a complete list of the species under their English and specific names, a calendar indicating when the egg, larva, pupa or imago appear, together with general remarks, range, food-plants, rearing hints, etc. This is followed by a systematic list of Families, Sub-families, Genera and Species and the English names. There is an excellent List of Food-plants and Alphabetical Indices.

O'Kane, W. C.—Injurious Insects, how to recognize and control them. Pp. 414 and 606 figs. New York: The Macmillan Company, 1912. Price, 8s. 6d. net.

The demand for semi-popular works on the injurious insects of the United States seems to be unlimited, if one may judge from the number of such issued on the subject.

Mr. O'Kane's book is written much on the same lines as others, generally speaking it is well illustrated, but in a few cases the insects are

not recognisable. Good line blocks or woodcuts might surely have easily been obtained. The arrangement of the matter leaves much to be desired, but the information is clear and concise.

The first hundred pages are devoted to a general account of the structure, behaviour, transformation, classification and distribution of insects; their natural enemies and control. This is followed by a description of the insect pests of garden and field crops, orchard and small fruits, household and stored products, and those of domestic animals.

References are given to more detailed accounts of the insects treated of, and there is an excellent index.

Peabody, J. E., and A. E. Hunt.—Elementary Biology, Animal and Human. Pp. xiv + 194 + 212 and 228 figs. New York: The Macmillan Company, 1912. Price, 4s. 6d. net.

This work is written on similar lines to that issued by the same authors on plant biology, and for the class of students it is intended for we do not know of a better book. It is essentially characteristic of that school of biologists who prefer living animals to dead ones for purposes of teaching young students, and the physiology rather than the morphology.

The two volumes have recently been issued as one, and we heartily commend it to all teachers who wish to infuse life and interest to an already fascinating subject.

Walter, H. E.—Genetics: An Introduction to the Study of Heredity. Pp. xiv + 272, 72 figs. New York: The Macmillan Company, 1913. Price, 6s. 6d. net.

The science of Genetics is one that in a comparatively short time has attracted a host of brilliant and distinguished workers, and as a branch of biological science concerns everyone. The literature on the subject is already voluminous, and there is an unceasing annual addition. The intelligent, but uninitiated, reader is therefore somewhat handicapped in his endeavour to rightly grasp the scope and aim of the subject.

The author of the work before us has given such readers just the book they require. His experience as a teacher has proved of considerable value in assisting him to grasp the situation. As concisely as desirable he has treated of problems most complex and difficult, in a manner that no intelligent reader can fail to appreciate.

For the general reader and student there is no book on the subject approaching this in lucidity, scope, and conciseness, and we strongly recommend it to such, as the most interesting and valuable epitome of the subject we have yet seen.

CURRENT LITERATURE.

I.—General Subject.

Bulletin of the Bureau of Agricultural Intelligence and of Plant Diseases. Nos. 9-12, 1912; Nos. 1-3, 1913. Rome: International Institute of Agriculture.

Monthly Bulletin of the Bureau of Economic and Social Intelligence. Nos. 8-12, 1912; Nos. 1, 2 and 4, 1913. Rome: International Institute of Agriculture.

Toyama, K.—Maternal Inheritance and Mendelism. Journ. Gen., 1913, vol. 2, pp. 351-405, pl. xx.

II.—Anatomy, Physiology, and Development.

Hilton, W. A.—The Central Nervous System of *Aphorura*. Journ. Entom. and Zool., 1913, vol. 5, pp. 37-42, 4 figs.

Johnston, C. E.—The Internal Anatomy of *Icerya purchasi*. Anns. Entom. Soc. Amer., 1912, vol. 5, pp. 383-388, plt. xxviii.

M'Connell, Edith.—Some Remarks on the Abdominal Air Sacs of *Stenopelmatus*. Journ. Econ. and Zool., 1913, vol. 5, pp. 47-49, 2 figs.

Matheson, R.—Structure and Metamorphosis of the Fore-Gut in *Corydalis cornutus*, L. Journ. Morph., 1912, vol. 23, pp. 581-624, plts. i-iv.

Philiptschenko, J.—Beiträge zur Kenntnis der Apterygoten. III. Die Embryonal entwicklung von *Isotoma cinerea*, Nic. Zeit. f. wiss. Zool., 1912, Bd. 103, pp. 519-660, T. 10-14.

Robinson, L. E., and J. Davidson.—The Anatomy of *Argas persicus* (Oken, 1818). Pt. I. Parasitology, 1913, vol. 6, pp. 20-48, plts. i-vi and 2 figs.

Trägårdh, I.—Contributions towards the Comparative Morphology of the trophi of the Lepidopterous Leaf-Miners. Arkiv för Zoologi, 1913, Bd. 8, pp. 1-48, 67 figs.

III.—General and Systematic Biology, and Geographical Distribution.

Alexander, C. P.—A Revision of the South American Dipterous Insects of the Family *Ptychopteridae*. Proc. U.S. Nat. Mus., 1913, vol. 44, pp. 331-335, 3 figs.

Bacon, Gertrude.—Two New Species of Collembola from the Mountains of Southern California. Journ. Entom. and Zool., 1913, vol. 5, pp. 43-46, 3 figs.

Bradley, J. C.—The *Siricidae* of North America. Journ. Entom. and Zool., 1913, vol. 5, pp. 1-35, 39 figs.

Bruner, L.—Results of the Yale Peruvian Expedition of 1911. Orthoptera (*Acridiidae*—Short-horned Locusts). Proc. U.S. Nat. Mus., 1913, vol. 44, pp. 177-187.

Cameron, P.—On some new and other Species of non-parasitic Hymenoptera in the Collections of the Zoological Branch of the Forest Research Institute, Dera Dun. Ind. For. Rec., 1913, vol. 4, pt. ii, pp. 21-33.

Cameron, P.—On the Parasitic Hymenoptera reared at Dehra Dun, Northern India, from the Lac (*Tachardia*) and Sal Insects. Ind. For. Rec., 1913, vol. 4, pt. ii, pp. 1-20.

Carpenter, G. D. H.—The Life-History of *Pseudacraea eurytus hobleyi*, Neave. Trans. Entom. Soc. Lond., 1912, pp. 706-716.

Casteel, D. B.—The Behaviour of the Honey Bee in Pollen Collecting. U.S. Dept. Agric., Bur. of Entom., Bull. No. 121, 1912, pp. 1-36, 9 figs.

Caudell, A. N.—Results of the Yale Peruvian Expedition of 1911. Orthoptera (Exclusive of *Acridiidae*). Proc. U.S. Nat. Mus., 1913, vol. 44, pp. 347-357.

Cockerell, T. D. A.—Two New Coccidae. Journ. Econ. Entom., 1913, vol. 6, pp. 142, 143.

Dutt, G. R.—Life-histories of Indian Insects—IV (Hymenoptera). Mem. Dept. Agric. India, 1912, vol. 4, No. 4, pp. 183-267, plts. xi-xiv and 22 figs.

Dyar, H. G.—Descriptions of New Species of Saturnian Moths in the Collection of the United States National Museum. Proc. U.S. Nat. Mus., 1913, vol. 44, pp. 121-134.

Dyar, H. G.—Descriptions of New Lepidoptera chiefly from Mexico. Ibid., pp. 279-324.

Girault, A. A.—A New Genus of Chalcidoid. Journ. Entom. and Zool., 1913, vol. 5, p 53, 54.

Hewitt, C. G.—Legislation in Canada to Prevent the Introduction and Spread of Insects, Pests and Diseases Destructive to Vegetation. Dept. Agric. Canada, Div. of Entom., Bull. No. 12—sec. ser., 1912, pp. 1-36.

Johnston, F. A.—On the Feeding Habits of *Pimpla* (*Itoplectis*) *conquisitor*, Say. Journ. Econ. Entom., 1913, vol. 6, pp. 144-147.

Kieffer, J. J.—Nouvelle contribution à la connaissance des Cécidomyies. Marcellia, 1912, vol. 11, pp. 219-235, 1 fig.

Malloch, J. R.—The Insects of the Dipterous Family *Phoridae* in the United States National Museum. Proc. U.S. Nat. Mus., 1912, vol. 43, pp. 411-529, plts. 35-41.

Malloch, J. R.—One new Genus and Eight new Species of Dipterous Insects in the United States National Museum. Proc. U.S. Nat. Mus., 1912, vol. 43, pp. 649-658, plt. 46.

Malloch, J. R.—Descriptions of New Species of American Flies of the Family *Borboridae*. Ibid., 1913, vol. 44, pp. 361-372.

Malloch, J. R.—Two New Species of Diptera in the United States National Museum Collection. Ibid., pp. 461-463.

Martin, C. H.—Some remarks on the behaviour of the Kinetonucleus in the division of Flagellates: With a note on *Prowazekia terricola,* a new Flagellate from sick soil. Zool. Anz., 1913, Bd. 41, pp. 452-456.

Neumann, L.-G.—Sur le genre *Gyropus*, Nitzsch. Ibid., pp. 212-228, 13 figs.

Neumann, L.-G.—Notes sur les Pédiculidés. III. Bull. Soc. Zool. France, 1912, T. 37, pp. 141-145, 6 figs.

Neumann, L.-G.—Sur le genre *Laemobothrion*, Nitzsch. Bull. Mus. d'Hist. nat. Paris, 1912, pp. 339-342.

Orton, C. R.—Correlation between certain Species of *Puccinia* and *Uromyces*. Mycologia, 1912, vol. 4, p. 194-204, plts. 70-71.

Pethybridge, G. H.—On the Rotting of Potato Tubers by a new species of Phytophthora having a method of Sexual Reproduction hitherto undescribed. Sci. Proc. Roy. Dub. Soc., 1913, vol. 13, pp. 529-565, plts. 42-44.

Pethybridge, G. H., and P. A. Murphy.—On Pure Cultures of *Phytophthora infestans*, De Barry, and the development of Oospores. Sci. Proc. Roy. Dub. Soc., 1913, vol. 13, pp. 566-588, plts. 45, 46.

Quaintance, A. L., and A. C. Baker.—Classification of the *Aleyrodidae*. Pt. I. U.S. Dept. Agric., Bur. of Entom., Tech. Ser. No 27, pt. 1, 1913, pp. 1-93, plts. i-xxxiv, and 11 figs.

Swaine, J. M.—New Species of the Family *Ipidae* (*Coleoptera*). Canadian Entom., 1912, vol. 44, pp. 349-353.

Toepffer, A.—Zweiter Beitrag zur Kenntnis arktischer und russischen Weidengallen. Marcellia, 1912, vol. 11, pp. 236-240.

Townsend, C. H. T.—Descriptions of New Genera and Species of Muscoid Flies from the Andean and Pacific Coast Regions of South America. Proc. U.S. Nat. Mus., 1912, vol. 43, pp. 301-367.

Trotter, A.—Contributo alla conoscenza delle galle della Tripolitania. Marcellia, 1912, vol. 11, pp. 210-219, 1 fig.

Viereck, H. L.—Descriptions of One New Family, Eight New Genera, and Thirty-three New Species of Ichneumon-Flies. Proc. U.S. Nat. Mus., 1912, vol. 43, pp. 575-593.

Viereck, H. L.—Results of the Yale Peruvian Expedition of 1911. Hymenoptera—*Ichneumonoidea.* Ibid., 1913, vol. 44, pp. 469, 470.

Wodsedalek, J. E.—Life-history and Habits of *Trogoderma tarsale,* Melsh., a Museum Pest. Anns. Entom. Soc. Amer., 1912, vol. 5, pp. 367-381, plt. xxvii.

IV.—Agriculture and Horticulture.

Blake, M. A., and A. J. Farley.—Report of the Horticulturist. 32nd Ann. Rpt. New Jersey Agric. Exp. Stat., 1912, pp. 63-86.

Britton, W. E.—Recent Studies on the Weevil and Bud Moth of the Walnut and a Sawfly attacking Blackberry. Journ. Econ. Entom., 1913, vol. 6, pp. 197-199.

Bryant, H. C.—Birds in Relation to a Grasshopper Outbreak in California. Univ. of Cal. Publications in Zool., 1912, vol. 2, No. 1, pp. 1-20.

Burgess, A. F., and D. M. Rogers.—Results of Experiments in Controlling the Gipsy Moth by removing its favourite food plants. Journ. Econ. Entom., 1913, vol. 6, pp. 75-79.

Burgess, A. F.—The Dispersion of the Gipsy Moth. U.S. Dept. Agric., Bur. of Entom., Bull. No. 119, 1913, pp. 1-62, plts. i-xvi, 6 text figs. and Map.

Button, W. E.—Twelfth Report of the State Entomologists, 1912. Connecticut Agric. Exp. Stat., 1912, pp. viii + 209-296, xvi plts.

Cadorel, A.—Le Puceron lanigère; un remède pratique et efficace. La Progres agric. et viticoli, 1913, pp. 52, 53.

Davis, J. J.—The Life Cycle of *Lachnosterna tristis,* Fabr. Journ. Econ. Entom., 1913, vol. 6, pp. 276-278.

Davis, J. J.—Report on Insects Injurious to Flowering and Ornamental Greenhouse Plants in Illinois. 27th Rpt. State Entom. Illinois, 1912, pp. 83-143, 52 figs.

Dean, G. A.—Further Data on Heat as a means of Controlling Mill Insects. Journ. Econ. Entom., 1913, vol. 6, pp. 40-53.

Dudgeon, G. C.—The Pink Boll Worm (*Gelechia gossypiella*, Saunders). Agric. Journ. of Egypt, 1913, vol. 11, pp. 1-4, pl. ii.

Essig, E. O.—Injurious and Beneficial Insects of California. Mon. Bull. State Comms. Hort. Sacr., Calif., 1913, vol. 2, pp. xxxi + 367, 321 figs.

For the orchardist or horticultural official this is an excellent publication, always clear, wonderfully concise, and eminently practical. The illustrations surpass anything we have previously seen in publications of this kind.

Essig, E. O.—The Control of the Pernicious or San José Scale. Journ. Econ. Entom., 1913, vol. 6, pp. 270-273.

Fiske, W. F.—The Gipsy Moth as a Forest Insect. U.S. Dept. Agric., Bur. of Entom., Circ. No. 164, 1913, pp. 1-20.

Forbes, S. A.—The Corn Root-aphis in Illinois. Agric. Exp. Stat., Univ. Illinois, 1913, pp. 1-7.

Foster, S. W.—The Cherry Fruit Sawfly. U.S. Dept. Agric., Bur. of Entom., Bull. No. 116, pt. iii, 1913, pp. 73-79, 2 plts. and 2 figs.

Gill, J. B.—The Fruit-tree Leaf-Roller (*Archips argyrospila*, Walk.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 116, pt. v, 1913, pp. 91-110, plts. xii-xvi.

Girault, A. A.—Insects Injurious to Stored Grains and their Ground Products. 27th Rpt. State Entom. Illinois, 1912, pp. 56-82, 12 figs.

Green, E. E.—Stem and Root Borer of Hevea Rubber (*Batocera rubra*, L.). Dept. Agric., Ceylon, Bull. No. 3, 1913, pp. 53-59, 1 plt.

Grossenbacher, J. G.—Crown-rot of Fruit Trees: Field Studies. New York Agric. Exp. Stat., Tech. Bull. No. 23, 1912, pp. 1-59, 56 figs.

Haseman, L.—Peach "Stop Back" and Tarnished Plant Bug. Journ. Econ. Entom., 1913, vol. 6, pp. 237-240.

Haseman, L.—The Apple Leaf-Hopper (*Empoasca mali*, Le B.). Ibid., pp. 240-243.

Hodge, C. F.—A New Fly Trap. Journ. Econ. Entom., 1913, vol. 6, pp. 110-112, plt. i.

Holloway, T. E.—Insects liable to Dissemination in Shipments of Sugar-Cane. U.S. Dept. Agric., Bur. of Entom., Circ. No. 165, 1912, pp. 1-8.

Holloway, T. E.—Field Observations on Sugar-Cane Insects in the United States in 1912. U.S. Dept. Agric., Bur. of Entóm., Circ. No. 171, 1913, pp. 1-8.

Hungerford, H. B.—The Success of a Two-Spray Calendar in a Kansas Orchard. Journ. Econ. Entom., 1913, vol. 6, pp. 165-173.

Hunter, W. D., and others.—The Principal Cactus Insects of the United States. U.S. Dept. Agric., Bur. of Entom., Bull. No. 133, 1912, pp. 1-71, plts. i-vii and 8 figs.

Hunter, W. D., and W. D. Pierce.—The Movement of the Cotton Boll Weevil in 1912. U.S. Dept. Agric., Bur. of Entom., Circ. No. 167, 1913, pp. 1-3, 1 fig.

Johnson, F., and A. G. Hammar.—The Grape-Berry Moth (*Polychrosis viteana*, Clem.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 116, pt. ii, 1912, pp. 15-71, plts. iv-viii and 18 figs.

Jones, T. H.—Some Notes on *Laphygma frugiperda*, S. and A. in Porto Rico. Journ. Econ. Entom., 1913, vol. 6, pp. 230-236.

Jones, P. R., and W. M. Davidson.—Life-history of the Codling Moth in the Santa Clara Valley of California. U.S. Dept. Agric., Bur. of Entom., Bull. No. 115, pt. iii, pp. 113-181, 13 figs.

Lipman, J. G., and others.—Report of the Soil Chemist and Bacteriologist. 32nd Ann. Rpt. New Jersey Agric. Exp. Stat., 1912, pp. 159-267.

Pages 213-229 contain a valuable paper detailing experiments relating to the possible influence of protozoa on ammonification in soils.

Long, H. C.—The Narcissus Fly. Gardeners' Chron., 1912, vol. 52, pp. 278, 279.

Marsh, H. O.—The Horse-radish Webworm (*Plutella armoracia*, Busck). U.S. Dept. Agric., Bur. of Entom., Bull. No. 109, pt. vii, 1913, pp. 71-76, 4 figs.

Maxwell-Lefroy, H.—The Psylla Disease of Indigo in Behar. Agric. Journ. India, 1913, vol. 8, p. 1-26, plts. i-iv.

Morgan, A. C., and G. A. Runner.—Some Experiments with Roëntgen Rays upon the Cigarette Beetle, *Lasioderma serricorne*, Fabr. Journ. Econ. Entom., 1913, vol. 6, pp. 226-230.

Munn, M. T.—Lime-Sulphur *v.* Bordeaux Mixture as a Spray for Potatoes, II. New York Agric. Exp. Stat., 1912, pp. 319-326.

Newell, W.—Notes on the Rice Water Weevil (*Lissorhoptrus simplex*, Say.), and its Control. Journ. Econ. Entom., 1913, vol. 6, pp. 55-61.

Oswald, W. L. and A. Boss.—Minnesota Weeds. Series 1. Agric. Exp. Stat. Univ. Minnesota, Bull. 129, 1913, pp. 1-82, 49 figs.

Parker, W. B.—Flour Paste as a Control for Red Spiders and as a Spreader for Contact Insecticides. U.S. Dept. Agric., Bur. of Entom., Circ. No. 166, 1913, pp. 1-5, 2 figs.

Parrott, P. J., and B. B. Fulton.—Notes on Tree Crickets. Journ. Econ. Entom., 1913, vol. 6, pp. 177-180, 15 figs.

Parrott, P. J., and W. J. Schoene.—The Apple and Cherry Ermine Moths. New York Agric. Exp. Stat., Tech. Bull. No 24, 1912, pp. 3-40, plts. i-ix and 10 figs.

Patch, Edith M.—Elm Leaf Curl and Woolly Apple Aphid. Maine Agric. Exp. Stat., Bull. No. 203, 1912, pp. 235-258, 3 plts.

Quayle, H. J.—Red Spiders and Mites of Citrus Trees. Univ. of Calif., Agric. Exp. Stat., Bull. No. 234, 1912, pp. 483-530, 35 figs.

Quayle, H. J.—Some Natural Enemies of Spiders and Mites. Journ. Econ. Entom., 1913, vol. 6, pp. 85-88.

Quayle, H. J.—The Grape-leaf Hopper. Mon. Bull. State Comms. Hort., Sacr., Cal., 1913, pp. 375-382.

Rizzi, M.—Sullo sviluppo dell'uovo di *Bombyx* (*Sericaria*) *mori,* L. Redia, 1912, vol. 8, pp. 323-359, T. ii-v.

Russell, H. M.—The Red-banded Thrips (*Heliothrips rubrocinctus,* Giard.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 99, pt. ii, 1912, pp. 17-29, plts. iv, v.

Schoene, W. J.—Notes on Comparative Tests with Zinc Arsenite and Arsenate of Lead. Journ. Econ. Entom., 1913, vol. 6, pp. 157-159.

Scott, E. W., and E. H. Siegler.—Lime-sulphur as a Stomach Poison for Insects. U.S. Dept. Agric., Bur. of Entom., Bull. No. 116, pt. iv, 1913, pp. 81-90, plt. xi.

Severin, H. H. P.—Precautions taken and the Danger of Introducing the Mediterranean Fruit Fly (*Cratitis capitata,* Weid.) in the United States. Journ. Econ. Entom., 1913, vol. 6, pp. 68-73.

Seymour, G.—Results of Spraying for Irish Blight. Journ. Dept. Agric. Victoria, 1912, vol. 10, pp. 745-752.

Shaw, F. J. F.—Anthracnose of Sisal Hemp. Agric. Journ. India, 1913, vol. 8, pp. 65-68, plts. xvi-xviii.

Smith, C. O.—Further Proof of the Cause and Infectiousness of Crown Gall. Univ. of Calif., Agric. Exp. Stat., Bull. No. 235, 1912, pp. 531-557, 28 figs.

Smith, J. B.—Report of the Entomologist. 32nd Ann. Rpt. New Jersey Agric. Exp. Stat., 1912, pp. 403-501, 8 figs.

Smith, J. B.—Report on the Mosquito Work for 1911. 32nd Ann. Rpt. New Jersey Agric. Exp. Stat., 1912, pp. 503-582, 5 figs.

Smith, R. E., and others.—Walnut Culture in California.—Diseases affecting the Walnut. Univ. of Calif., Agric. Exp. Stat., Bull. No. 231, 1912, pp. 119-319, 77 figs., and 320-398, 19 figs.

Stewart, F. C., and others.—Potato-Spraying Experiments, 1902-1911. New York Agric. Exp. Stat., Bull. No. 349, 1912, pp. 99-139.

Teodoro, G.—Sulla struttura delle valve anali del *Lecanium oleae,* Bern. Redia, 1913, vol. 8, pp. 458-461, fig. 1, 2.

Theobald, F. V.—An Unrecorded Apple Sawfly in Britain (*Lygaeonematus moestus,* Zaddach). Entomologist, 1913, pp. 108, 109.

Treherne, R. C.—Life-history of *Otiorhynchus ovatus,* the Strawberry Root Weevil. Proc. Brit. Columbia Entom. Soc., 1912, pp. 41-50.

Urich, F. W., and O. Heidemann.—Notes on some Mexican Sugar-Cane Insects. Journ. Econ. Entom., 1913, vol. 6, pp. 247-251, plt. 7 and 1 fig.

Van Dine, D. L.—The Insect Affecting Sugar-Cane in Porto Rico. Journ. Econ. Entom., 1913, vol. 6, pp. 251-257.

Volck, W. H.—The Control of Red Spiders. Mon. Bull. State Comms. Hort., Sacr., Cal., 1913, vol. 2, pp. 356-363.

Whitney, B. B.—A New California Coccid Infesting Manzanita (*Aulacaspis manzanitae,* n.sp.). Journ. Entom. and Zool., 1913, vol. 5, pp. 50-52, 2 figs.

Woglum, R. S.—Report of a Trip to India and the Orient in search of the Natural Enemies of the Citrus White Fly. U.S. Dept. Agric. Bur of Entom., Bull. No. 120, 1913, pp. 1-58, 12 plts.

Yothers, W. W.—The Effects of Oil Insecticides on Citrus Trees and Fruits. Journ. Econ. Entom., 1913, vol. 6, pp. 161-165.

V.—Forestry.

Rohiver, S. A.—Chalcidids Injurious to Forest-Tree Seeds. U.S. Dept. Agric., Bur. of Entom., Tech. Ser. No. 20, pt. vi, 1913, pp. 157-163.

VI.—Fisheries.

VII.—Medicine.

Brues, C. T.—The Relation of the Stable Fly (*Stomoxys calcitrans*) to the Transmission of Infantile Paralysis. Journ. Econ. Entom., 1913, vol. 6, pp. 101-109.

Forbes, S. A.—On Black-Flies and Buffalo-Gnats (*Simulium*) as possible carriers of Pellagra in Illinois. 27th Rpt. State Entom. Illinois, 1912, pp. 21-55, 25 figs.

Hunter, W. D.—American Interest in Medical Entomology. Journ. Econ. Entom., 1913, vol. 6, pp. 27-39.

Hunter, S. J.—Pellagra and the Sand-Fly. II. Journ. Econ. Entom., 1913, vol. 6, pp. 96-99.

Longfellow, R. C.—The Common House Roach as a Carrier of Disease. Amer. Journ. Pub. Health, 1913, vol. 3, pp. 58-61.

VIII.—Animal Diseases, Etc.

Bishopp, F. C.—The Fowl Tick (*Argas miniatus*, Koch). U.S. Dept. Agric., Bur. of Entom., Circ. No. 170, 1913, pp. 1-14, 5 figs.

Bishopp, F. C.—The Stable Fly (*Stomoxys calcitrans*, L.), an important live stock pest. Journ. Econ. Entom., 1913, vol. 6, pp. 112-126, plts. ii, iii.

Bishopp, F. C., and W. V. King.—Additional Notes on the Biology of the Rocky Mountain Spotted-Fever Tick. Journ. Econ. Entom., 1913, vol. 6, pp. 200-211.

Cooley, R. A.—Notes on little known Habits of the Rocky Mountain Spotted Fever Tick (*Dermacentor venustus*, Banks). Journ. Econ. Entom., 1913, vol. 6, pp. 93-95.

Herrick, G. W.—Some External Insect Parasites of Domestic Fowls. Journ. Econ. Entom., 1913, vol. 6, pp. 81-84.

Holmes, J. D. E.—A Note on Some Interesting Results following the Internal Administration of Arsenic in Canker and other Diseases of the Foot in Horses. Agric. Research Inst., Pusa, Bull. No. 32, 1912, pp. 1-5.

Kaupp, B. F.—Some Poultry Diseases. Colorado Agric. Exp. Stat., Bull. No. 185, 1912, pp. 1-30, 29 figs.

Townsend, C. H. T.—The Possible and Probable Etiology and Transmission of Verruga Fever. Journ. Econ. Entom., 1913, vol. 6, pp. 211-225.

White, G. F.—Sacbrood: a Disease of Bees. U.S. Dept. Agric., Bur. of Entom., Circ. No. 169, 1913, pp. 1-5.

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THE

JOURNAL OF ECONOMIC BIOLOGY.

THE BRITISH SPECIES OF THE GENUS *MACROSIPHUM*, PASSERINI.

Pt. II.

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WITH 29 FIGURES.

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26. **Macrosiphum convolvuli** (Kaltenbach).

Aphis vincae, Walker.
Siphonophora convolvuli, Buckton.

Ann. Nat. Hist., Ser. 2, II, p. 429, 52. Mono. Pflanz., p. 40, Kaltenbach; Mono. Brit. Aph., I, p. 148, pl. xxi, Buckton.

Apterous viviparous female.—Green, tinged with rusty-red at the base of the cornicles and on the posterior portion of the abdomen.

Antennae pale yellowish-brown to brown, dark at the apices of the segments, and the sixth segment all dark brown; the third segment longer than the fourth, the fourth longer than the fifth, the sixth about as long as four and five together; the third segment has one to two sensoria near its base, and all the segments are imbricated; the whole antenna not quite as long as the body to about its length; frontal prominences marked. Two short, thick hairs on the frons. Eyes black. Proboscis green, with blackish apex,

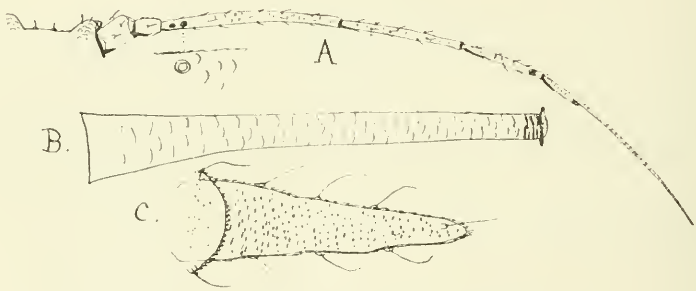


Fig. 31.—*Macrosiphum convolvuli* (Kaltenbach).
Apterous female. Antenna, A; Cornicle, B, and Cauda, C.

reaching to the second coxae. Legs green, apices of femora and tibiae dark and the tarsi; tibiae hairy, femora with a few hairs. Cornicles pale green, with rusty-brown apices, imbricated, moderately long and thin, expanded at the base. Cauda pale, rusty-brown to green, about two-thirds the length of the cornicles, with three hairs on each side and an apical submedian one.

Length.—2.5 to 2.8 mm.

Alate viviparous female.—Green. Head, band on prothorax and mesothorax shiny-black; third antennal segment tuberculate. Abdomen bright green, with a broad, blackish patch on the dorsum and four cross stripes, three large lateral spots. Cornicles green, tipped with black. Legs ochreous, rather short, femora and tibiae tipped with black. Tail small, green. Wings with pale yellow insertions and yellow cubitus; stigma grey; veins ginger-yellow.

Localities.—Stouting, near Hythe, Kent and Wye; Chichester and Haslemere (Buckton).

Food plants.—Periwinkle (*Vincia minor* and *V. major*); *Convolvulus major, C. minor* and *C. sepium; Nemophila.*

Notes.—Taken by Mr. Adrien Duffield on April 27th, 1913, occurring in some numbers on Periwinkle, and by Buckton in June, at Chichester and Haslemere. I found a single apterous female at Wye on *Convolvulus* on June 20th, in 1911.

This very marked species can at once be told by the rusty-red markings on the abdomen. The structure of the frontal prominences is also marked, and resembles to some extent in this respect the *Macrosiphum crataegarium* of Walker.

Walker's *Aphis vincae* is apparently the same as Kaltenbach's *A. convolvuli.*

Kaltenbach found it in August and September.

27. **Macrosiphum polygoni** (Buckton).

Siphonophora polygoni, Buckton.

Mono. Brit. Aph, I, p. 123, pl. x, figs. 1-3.

Alate viviparous female.—Yellowish to green. Head, prothorax and thoracic lobes and scutellum deep brown, the prothorax with a yellow band in front. Abdomen with four or five broken transverse bands, three large dark spots at the sides of the bands, and five smaller marginal spots and a semi-circular one over the base at each cornicle. Cornicles black, expanded basally, rather long. Cauda yellow, about one-third the length of the cornicles. Legs yellow and hairy, black femoral and tibial apices and black tarsi. Venter clear yellow, with dark brown mesosternum and anal valve.

Length.—1.7 mm. *Wing expanse,* 8 mm.

Apterous female.—Pale yellow; long antennae, dusky at the tip and apices of the segments; tips of tibiae and the tarsi dark. Cornicles dark.

Length.—2.5 mm.

Localities.—Haslemere (Buckton); Barmouth, N. Wales (Theobald).

Food plant.—*Polygonum persicariae.*

Notes.—Buckton found pupae and alatae at the end of June. I have a note of finding this species as apterous females in May, near Barmouth, in 1905. It is a very marked species. I have been unable to find it in recent years, so can give no figures of the antennae, etc.

It is possible that the oviparous female and male described by

Walker (Zoologist, VI, p. 2249) from *Polygonum aviculare* are the same species; if so, the species will stand to Walker, not Buckton. Walker's descriptions are as follows:—Oviparous female. Apterous, small, dull brown to yellowish on each side, granulated, flat and narrow; antennae pale yellow, brown at base, black towards tips, first and second joints brown, third and fourth white; rostrum pale yellow, its tip and eyes black. Abdomen shorter than thorax; legs short, pale yellow, tip of tarsi black, hind tibiae brown.

Male wingless. Antennae black, half length of body.

Newcastle, October. (*Aphis polygoni*).

28. **Macrosiphum scrophulariae** (Buckton).

Siphonophora scrophulariae, Buckton.

Mono. Brit. Aph., I, p. 137, pl. xvi, figs. 1 and 2.

Found by Buckton at Haslemere in July, on *Scrophularia scorodonia*. I have failed to find this species. It is very marked, the apterae being pale ashy, almost white, pilose and translucent; antennae long and hairy.

The alate female is bright yellow, with brown thoracic lobes and transverse stripes on the abdomen, yellow cornicles and cauda.

29. **Macrosiphum circumflexum** (Buckton).

Siphonophora circumflexa, Buckton.

Mono. Brit. Aph., I, p. 130, pl. xiii.

Alate viviparous female.—Green; head and thorax dark, the abdomen with various irregular dark markings, a common type being a semi-circular patch behind the scutellum, then five broken bands, and two more prominent ones near the apex; in others the bands fuse before the cornicles to form a dark patch, and in others

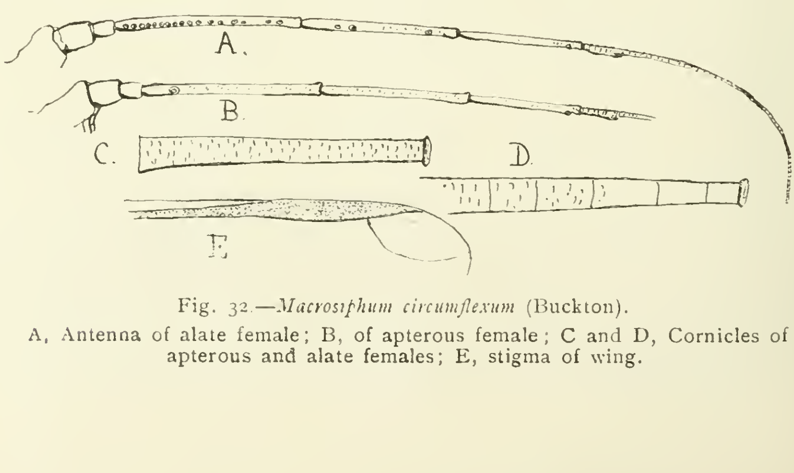


Fig. 32.—*Macrosiphum circumflexum* (Buckton).
A, Antenna of alate female; B, of apterous female; C and D, Cornicles of apterous and alate females; E, stigma of wing.

the bands are more uniform, some few are almost all green on the abdomen. Cauda black. Antennae black, variable in length, as long, or slightly longer, than the body, the third segment with a line of about sixteen sensoria on one side, reaching to the tip of the segment, the last two separated by a small space from the others, fourth segment nearly as long as the third, with three sensoria, fifth shorter than the fourth, sixth very thin, considerably longer than the fourth and fifth together.

Cornicles cylindrical, dusky-green to black, no signs of ornamentation apically, but imbrication lower down and with four transverse bars.

Legs long and thin, femora dark, rest yellowish. Cauda moderately long, dusky to black. Wings very large, cubitus and stigma pale grey. Rostrum reaching the second coxae.

Length.—1.6 to 1.8 mm. *Wing expanse,* 8 mm.

Apterous viviparous female.—Bright, shiny, yellowish-green; thorax with one or two dark spots on each side. Abdomen with dark patches, one forming an irregular horse-shoe-shaped area, and a large dark patch. Antennae green to yellow, the apices of third to fifth segments dusky, and all the sixth; frontal tubercles marked; the third segment longer than the fourth, with a sensorium near the base, fifth a little shorter than the fourth, sixth longer than the fourth and fifth combined. Cornicles moderately long, yellow, imbricated, in some dusky at the tip. Cauda yellowish. Legs yellowish, tarsi dusky.

Some forms are all pale yellowish-green, and show no markings.

Length.—1.6 to 1.8 mm.

Localities.—All parts of Britain, under glass.

Food plants.—Arum lilies, Tulips, Chrysanthemums, Persimmon, Fresias, Cyclamen, Cinerareas, Spiraeas, Schizanthus, and probably many other greenhouse plants.

Notes.—A very abundant greenhouse pest. I have kept it for years, and have seldom been able to produce an alate generation, and never sexuparae. Asexual reproduction I have found may be continued for four years, how much longer I cannot say. I have found it in every month of the year, but it increases most rapidly in Arum lilies from February to May.

Buckton considers it an early spring species, in which I cannot agree, and says that the early winged forms do not develop such long antennae as those which emerge in June. The length of the antennae varies at all times. I have never been able to obtain alatae before early May.

The apterae are subject to enormous variations in colour, in fact from plain green to almost black, but there are always many specimens in a colony with the typical abdominal black markings.

No other species can be confused with it.

30. Macrosiphum longipennis (Buckton).

Siphonophora longipennis, Buckton.

Mono. Brit. Aph., I, pp. 146-148, pl. xx (*bis*).

Apterous viviparous female.—Yellow to yellowish-green, marked with rusty to red, elongated oval, somewhat widened in some behind, and narrowed towards the tail. Antennae thin, yellow, not quite as long as the body, apices of the fourth and fifth segments dusky, sixth dusky, the third segment is longer than the fourth, the fourth than the fifth, the sixth as long as the fourth and fifth together; the third has one or two sensoria at its base, and the fifth one near the apex, all the segments are faintly imbricated. Eyes large, black to deep red. Legs pale yellowish-green, the tarsi dusky, the tibiae with many short hairs. Cornicles moderately long, cylindrical, pale yellowish to yellowish-green, slightly dusky at the apex, faintly imbricated. Cauda rather long, pale yellowish, lanceolate.

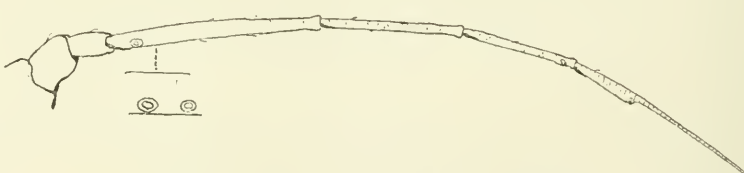


Fig. 33.—*Macrosiphum longipennis* (Buckton).
Antenna of apterous female.

Length.—1.5 to 2 mm.

Buckton describes the pupa and *alate viviparous female* as follows:—

Pupa.—Yellow. Head somewhat broad, with brown spots in the position of the stemmata. Prothorax with a carnation band or ring. Thorax and wing-cases pale yellow, the latter having strongly marked brown tips. Abdomen acuminate. Dorsum stained with carnation. Pore-marks red, with several carnation bands transversely connecting them. Tail yellow. Nectaries green and straight. Legs almost colourless. The femora are nearly as long as the tibiae. Eyes red. Antennae short, green, and seated on conspicuous frontal tubercles. *Length* of body, 1.77 mm.

Alate viviparous female.—Body almost linear or fusiform. Colour very much as in the pupae, except that the abdomen is free from the red pore-marks and bands. Thoracic lobes pale yellow. Tail pointed and yellow, about one-third the length of the cornicles, which are green, straight, and cylindrical. Antennae pale green, with darker tips. Frontal tubercles small. Legs almost white, with tibiae and femora of nearly equal length. Eyes red-brown. Stemmata red. Wings ample, hyaline and greenish, rather corrugated and finely punctured. Insertions, cubitus, stigma, and veins delicate green.

Length.—2.02 mm. *Wing expanse,* 8.12 mm.

Male.—Winged. Head, thoracic lobes, neck rings, tips of femora and tibiae rich brown. Tarsi nearly black. Antennae seated on well-developed frontal tubercles, which are somewhat porrected as in the genus *Myzus*. Abdomen brick-red, with brownish or grey transverse cloudings. Wings longer even than in the winged female.

Length.—1.77 mm. *Wing expanse,* 8.12 mm.

Localities.—Norwich (Buckton); Great Lalkeld, Penrith, Cumberland (Britten); Romney Marsh, Kent.

Food plant.—*Poa annua.*

Notes.—Buckton describes all stages of this species except the oviparous female from Norwich, where it was found in numbers in October, feeding on the blades and flower-stalks of *Poa annua.* Larvae and apterous females were sent me by Mr. Britten from Great Lalkeld in July, and I found two colonies in 1910 on Romney Marsh in June, on *Poa annua,* but I could find no alate forms. It evidently lives all the year upon that grass.

31. **Macrosiphum avellanae** (Schrank).

Aphis avellanae, Schrank.
Aphis coryli, Mosley.
Siphonophora avellanae, Koch and Buckton.

Fn. Boic., II, p. 112, n, 1207, Schrank; Mono. Pflanz., p. 143, Kaltenbach; Die Pflanz., p. 168, figs. 230, 231, Koch; Ann. Nat. Hist., Ser. 2, ii, p. 302, 64, Walker; Gard. Chron., I, p. 628, 1841, Mosley; Mono. Brit. Aph., I, p. 149, pl. xxii, Buckton.

Alate viviparous female.—Pale greenish-yellow. Head, band on pronotum, thoracic lobes and scutellum dark brown. Some of the cephalic and antennal hairs capitate. Antennae longer than the body, two basal segments deep brown, rest pale brown to yellowish. The third segment has a line of 13-15 sensoria nearly extending to the apex; 3rd to 6th segments imbricated. Eyes red. Cornicles pale

green, between them is often a smoky patch on the abdomen; reticulate at the apex, imbricated below. Legs pale yellowish-brown, femora and tibiae darkened at the apices, tarsi dusky, hairy. Wings with yellowish insertions and brown stigma, long. In some specimens the cornicles are dark at the tips and the legs pale brown.

Length.—1.7 to 2 mm. *Wing expanse*, 7 to 7.5 mm.

Apterous viviparous female.—Pale, soft green, tinged with dull reddish in front, and sometimes at the sides, some specimens all pale green, semi-transparent, very hairy. Antennae brown, as long as the body, arising from large frontal tubercles. Head very broad. Eyes red. Abdomen tuberculate, tufts of hairs arising from the tubercles. Cornicles long, thin, pale green. Cauda pale green. Legs pale brown, darkened at the apices of femora and tibiae, and dark tarsi. Antennae, legs and vertex hairy.

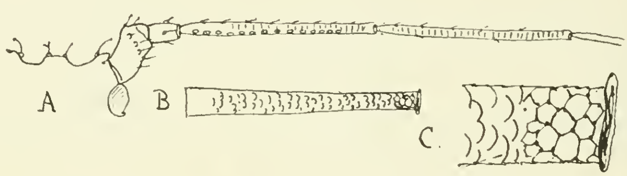


Fig. 34.—*Macrosiphum avellanae* (Schrank).
A, Antenna of alate female; B, Cornicle; C, Apex of cornicle further enlarged.

Length.—1.5 to 2 mm.

Immature forms white to pale green.

Localities.—Hollington, and Old Road, Hastings; Maidstone, Wye, Yalding, Kent; Kingston-on-Thames; Widdington, Essex; Histon, Cambridge, and Little Hadham, Herts.

Food plants.—Hazel (*Corylus avellana*), and on cultivated Cob and Filbert nuts.

Notes.—Very abundant in some years in Kent, swarming over the leaf-stalks and the shoots in the nut plantations. In other years scarcely one can be found.

It appears first in May, and alate forms from June to the end of August.

32. **Macrosiphum tussilaginis** (Walker).

Aphis tussilaginis, Walker.
Siphonophora tussilaginis, Koch.

Ann. Nat. Hist., Ser. 2, V, p. 390, 84, Walker; Die Pflanz., p. 158, figs. 213-214, Koch; Mono. Brit. Aph., I. p. 159, pl. xxvii fig. 3 Buckton. (?).

Apterous viviparous female.—Brown to pale brown; head dark. Antennae yellow, as long as, or a little longer than, the body, the

two basal segments and the sixth brown, and a narrow brown apex to the other segments, with five short hairs; frontal tubercles small. Proboscis yellow, black at the apex, reaching to the third coxae. Abdomen with five small dark lateral tubercles, with transverse rows of hairs, some arising from small dusky patches. Cornicles moderately long, about one-fourth the length of the body, yellow and black at the base and apex, cylindrical, somewhat expanded at the base. Cauda pale yellowish. Legs pale yellowish and long, a dusky spot at the femoro-tibial articulation, a dusky apex to the tibiae, and dusky tarsi; the femora and tibiae with fine short yellow hairs. Eyes black and reddish-black.

Length.—2 to 2.5 mm.

Alate viviparous female.—"Body brown; the borders and the under-side of the fore-chest are pale green; the abdomen pale green, with a narrow row of black bands along the back, and a row of black spots on each side; the feelers are black, and a little longer than the body; the mouth is pale yellow, its tip and the eyes black; the nectaries are yellow, with black tips, and as long as one-fourth of the

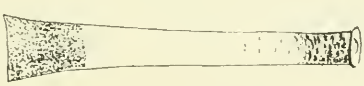


Fig. 35.—*Macrosiphum tussilaginis* (Walker). Cornicle of apterous female.

body; legs long and yellow; the hind thighs, except the base, the feet and the tips of the thighs and of the shanks black; the wings are colourless; the wing-ribs and the rib-veins pale yellow; the wing brands and the other veins brown." (Walker.)

Localities.—Lancaster (Walker); Haslemere (Buckton); Herne Bay, Kent (Theobald), 15.vii.1911 and 7.vii.1912; Guildford, 19.v.12.

Food plant.—*Tussilago farfara.*

Notes.—Found by Walker in October, by Buckton in July, and by myself in the same month and in May. The apterae swarmed under the leaves at Herne Bay, but no alatae were present, and when I went four weeks later there was no trace of the species. It is easily told by the marked cornicles, with their black base and apex, that I have not seen in any other British species.

Walker describes a variety in which the abdomen is yellowish-brown; the feelers are black, pale brown towards the base, and nearly twice the length of the body; the nectaries are yellow, with black

tips; they are also black at the base, where there is a large spot of the same colour. I am not sure if Buckton's species is the same, he describes the femora as dark brown, and being rich brown with a brassy lustre. It is probably, however, a variety, as the characteristic colouration of the cornicles is seen.

33. **Macrosiphum diplantereae** (Koch).

Siphonophora diplantereae, Koch.

Die Pflanz., p. 151, fig. 205, Koch.

Alate viviparous female.—Very similar to *M. pelargonii*, Kalt., but the third segment of the antennae has twenty-four or more sensoria going up to near the apex, the fourth segment nearly as long as the third, the third is deep brown except at the base, the fourth and fifth are paler, but become darkened towards their apices; the antennae are very long, being much longer than the body. The cornicles are very long and thin, cylindrical, with a few narrow reticulations at the apex, rest imbricated; the legs very long and thin,

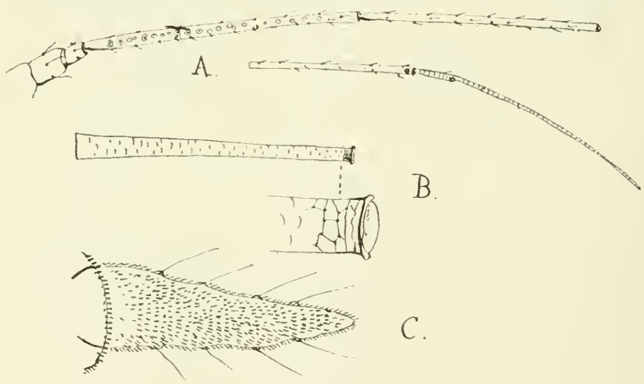


Fig. 36.—*Macrosiphum diplantereae* (Koch).
A, Antenna; B, Cornicle, and C, Cauda of alate female.

with broad black areas on the apices of the tibiae, dark tarsi, and traces of a dark spot at the apex of the femora. The wings are large, with yellowish-brown stigma and veins and yellow insertions. Proboscis yellowish-green, dark just at the apex. Cauda yellow, with four large bristles on each side, and very spiny.

Length.—3 mm. *Wing expanse,* 9 mm.

The apterae are green, with yellowish and pale-brown head and thorax; the young very pallid.

Locality.—Wye (9/6/1911).

Food plants.—*Diplantera formosa* (Koch); *Malva, spp.* (Theobald).

Notes.—This is a very uncommon species, which I feel sure is distinct. It certainly is from *M. pelargonii*, Kalt., under which it has been placed by Buckton, Schouteden and others.

The marked arrangement of the sensoria of the third antennal segment at once separates it, and also the very spinose nature of the cauda.

I fancy Passerini's *malvae* is the same. I have found apterae scattered about on wild malvas at Wye which answer to Koch's species, and bred the single alate form described here from a small colony on the Downs.

34. Macrosiphum menthae (Buckton).

Siphonophora menthae, Buckton.

Mono. Brit. Aph , I, p. 120, pl. ix, fig. 1 and 2.

I have failed to find this species. It is recorded by Buckton on garden mint, *Mentha viridis,* in July, and afterwards on *Sarothamnus scoparius.*

It is probably the same as the *Aphis menthae* of Walker. The apterous female is green, and transparent, eyes red, and the tips of the cornicles and leg segments dark. The frontal tubercles very large.

The alate female is bright green, thoracic lobes and scutellum olive. Abdomen with four dark spots on each side. Cornicles fine, and black.

35. Macrosiphum fragariae (Koch).

Siphonophora fragariae, Koch.

Die Pflanz., p. 173, fig. 327-328, Koch; Mono. Brit. Aph. I, p. 125, Buckton (part).

Alate viviparous female.—Reddish-yellow to green, with black head, thorax, antennae and cornicles. Legs reddish-yellow to greenish, with black apices to the femora and tibiae, and black tarsi, femora and tibiae hairy.

Abdomen with four black spots on each side, and several faint dorsal median marks, two large black spots caudad to the cornicles, followed by a smaller pair. Eyes black. Cauda pale reddish-yellow. Cornicles long and thin. Antennae longer than the body.

Length.—2.2 to 2.5 mm.

Apterous viviparous female.—Pale reddish-yellow to bright grass-green. Head and prothorax brown. Antennae as long as the body, black, base paler. On the abdomen are small black lateral spots, which spread out laterally, and behind the long black cornicles are two pairs of large brown spots. Cauda greenish. Legs as in the alate female.

Length.—2.5 mm.

Localities.—Kingston-on-Thames, Surrey (17.v.85); Wye, July, 1905-6; Swanley, 1902; Sevenoaks (2.v.90).

Food plant.—Strawberry.

Notes.—I took this species in 1885 at Kingston-on-Thames on garden strawberries, but have lost the specimens. Buckton records this species, but his apterous female is certainly not Koch's *fragariae,* for he describes it as wholly green, except the tips of the cornicles and the dark olive antennae.

The alate female is, however, Koch's species. He gives no locality. I have only notes on it from the other localities.

36. **Macrosiphum fragariellum** (Theobald).

Siphonophora fragariella, Theobald.

Rept. Econ. Zool. year ending Apl. 1, 1905, p. 35.

Alate viviparous female.—Head and antennae deep green to olive-brown; the two basal segments of the antennae very deep brown, base of the third pale grey, longer than the body, arising from well-marked frontal prominences; third segment with 38 to 45 sensoria, extending nearly to the apex, fourth slightly shorter than the third, and longer than the fifth, which has a single large pale sub-apical sensorium; sixth nearly as long as the fourth and fifth; hairs numerous, those on the third often slightly capitate. Eyes deep brown. Prothorax olive-green, a pale green band before and behind; thoracic lobes blackish, rest of the thorax deep green.

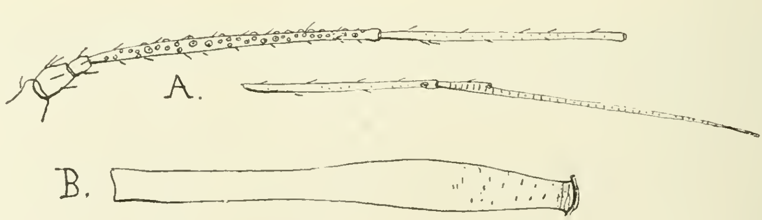


Fig. 37.—*Macrosiphum fragariellum* (Theobald).
A, Antenna, and B, Cornicle of alate female.

Abdomen bright rich green above, with an irregular median dusky line and broken dusky apical borders to the segments; green below, and with three dusky lateral spots before the cornicles. Proboscis green at the base, shiny, black at the apex, reaching past the second coxae. Cornicles jet black at the apex, long, swollen on the apical half, two striae at the apex, one forked.

Legs fawn-coloured, femora and tibiae black apically, tarsi black. Wings with grey stigma.

Length.—1.8 to 2.5 mm.

Apterous viviparous female.—Body bright shiny green, somewhat yellowish towards the centre. Head and thoracic segments pale yellowish-green. Eyes black. Cornicles long, thin, swollen towards the apex, green, apex black. Antennae very long, pale fawn, with dark tips to the segments. Legs fawn-coloured, uniform except the apex of tibiae and the tarsi. Proboscis yellow, dusky at the apex.

Length.—1.5 to 2 mm.

Pupa.—Entirely pure green, except for dark apices to the tibiae and black tarsi. Antennae green, with minute black apices to the basal segments forming three black spots, apical half of antennae dusky. Cornicles green, with black apices. Eyes black. Wing buds all green.

Length.—1.5 to 2 mm.

Localities.—Ledbury, Hereford; Woodnesborough, Dover, Kent; Hounslow, Middlesex; Rudgwick, Sussex.

Food plant.—Cultivated strawberries.

Notes.—This aphis, which was sent me in 1904, appeared in great numbers at Ledbury, and did considerable damage to the plants. It has also appeared in numbers in 1913 at the same place. It lives entirely on the strawberry, ova being found in February on plants sent me, and on those kept under control, but during my absence no sexuparae were kept. The ova are shiny black, and placed on the under-sides of the leaves near a vein, others almost at the edge of the leaf, most on old leaves, but not all. Some on young leaves, which show that sexuparae must have occurred very late. The ova hatch in March, and continue until the first week in April. The young are very sluggish, dark-green lice, and show scarcely any trace of frontal tubercles, and the cornicles are cylindrical, not narrowly clavate. It can at once be told from the other strawberry aphides by the shape of the cornicles. The formation of the cornicles might place this in *Rhopalosiphum,* but the large frontal tubercles include it in *Macrosiphum*.

37. **Macrosiphum rogersii**, n. sp.

Siphonophora fragariae, Buckton (part) (non Koch).

Apterous viviparous female.—Bright green. Eyes reddish-black. Antennae longer than the body, pale green, apices of third to fifth segments dusky, sixth dusky, the third a little longer than the fourth, the fourth than the fifth, the sixth not quite as long as the fourth and fifth; the third has a line of eight sensoria extending about two-thirds of the length of the segment, the fifth a large sub-apical sensorium; hairs short; all the segments imbricated; frontal processes fairly large, and a large prominence between. Abdomen pyriform, with two rows of black spots on the anterior half, irregularly disposed. Cornicles green, long, dusky just at the apex, cylindrical, but slightly expanding towards the base, projecting to about the level of the cauda; imbricated, with one or two striae at the apex. Cauda long, pale greenish-yellow, about two-thirds the

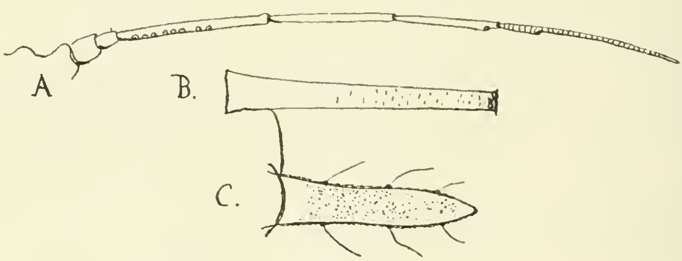


Fig. 38.—*Macrosiphum rogersii*, n. sp.
A, Antenna; B, Cornicle, and C, Cauda of apterous female.

length of the cornicles. Legs long, yellowish-green, apices of the tibiae and all the tarsi dark; hairs pale, fine and short.

Length.—2 mm.

Nymph.—Pale green; eyes reddish-black. Antennae green, third to fifth segments with black apices, sixth all dark. Wing-cases dusky. Legs greenish-yellow, rather darker than the body, apices of femora and tibiae dark, tarsi dark, Cornicles green, with dark apices, slightly darker than the body, which has a brighter green patch at the base of each cornicle.

Length.—2 mm.

Locality.—Hounslow.

Food plant.—Strawberry.

Notes.—This species, which is evidently the same as Buckton took to be the apterous female of Koch's *fragariae*, occurred in large numbers at Hounslow in May, 1912; specimens being sent me with

Myzus fragariae, Theobald, by the Board of Agriculture. It differs from Koch's species in having green cornicles, and in the green, not dark, head. It is named after Mr. A. G. L. Rogers, of the Board of Agriculture, who has sent me many aphides. This makes the fourth species of Aphid found on strawberries in this country.

38. **Macrosiphum chelidonii** (Kaltenbach).

Aphis chelidonii, Kaltenbach.
Siphonophora chelidonii, Koch and Buckton.

Mono. Pflanz., p. 41, Kaltenbach; Die Pflanz., p. 169, figs. 232, 233, Koch; Mono. Brit. Aph., I, p. 121, pl. ix, figs. 3, 4, Buckton.

Alate viviparous female.—Green, head and prothorax deeper green, thoracic lobes and scutellum brown. Antennae as long as the body, brown, base greenish. Proboscis green to yellow, apex brown. Cornicles long and thin, deep green. Cauda yellowish, moderately long. Legs yellowish-green, apices of femora and tibiae and all the tarsi dark. Wings with green insertions, stigma and cubitus. Eyes red.

Length.—2.2 to 2.5 mm. *Wing expanse*, 8.5 to 9 mm.

Apterous viviparous female.—Various shades of green to pale yellowish green, some specimens dull, others shiny. Antennae as long as the body, greenish-yellow, sixth segment brownish, and traces of brown on the apices of the fourth and fifth. Legs greenish-yellow to almost pale yellow, tarsi dusky. Cornicles long, thin, cylindrical, but slightly expanded at the base, apex slightly dusky. Cauda pale yellowish-green, rather short.

Length.—2.5 to 3 mm.

Localities.—Kingston-on-Thames; Cambridge; Wye, July, 1901 and 4; May, 1904; Crundale, May, 1909.

Food plant.—Great Celandine (*Chelidonium majus*) and Raspberry ?.

Notes.—Kaltenbach originally described this species from the Great Celandine. Buckton records it from the garden Raspberry. The species I have found on *Rubus* is distinct, and is described here as *M. rubiellum*, but I have an old record of it on raspberry at Wye.

39. **Macrosiphum solani** (Kaltenbach).

Aphis solani, Kaltenbach. (non *R. solani*, Theobald).
Mono. d. Pflanz., p. 15, Kaltenbach.

Apterous viviparous female.—Green, except for the apices of the third to fifth segments, a dusky patch around the sensoria on the sixth and its apex, also tips of tibiae, the tarsi and apices of the cor-

nicles dusky; antennae longer than the body; the third segment longer than the fourth, the fourth longer than the fifth; the sixth about as long as the fourth and fifth, two sensoria near base of third, hairs on basal area capitate. Eyes reddish-brown. Proboscis yellowish-green, dusky at apex. Legs yellowish-green, thin and long, apices of tibiae and tarsi dark. Cornicles long, thin, cylindrical, slightly expanded at the base, pale yellowish-green, apex dusky, with two transverse lines and two cross connections at apex, rest finely imbricated. Cauda pale yellowish, with three long hairs on each side.

Length.—2 to 2.5 mm.

Localities.—Great Lalkeld, Penrith; Helsby, Warrington (5.9.13).

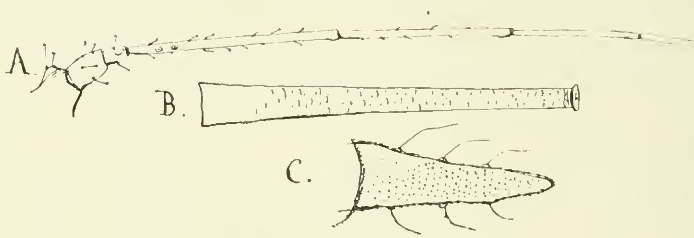


Fig. 39.—*Macrosiphum solani* (Kaltenbach).
A, Antenna; B, Cornicle, and C, Cauda of apterous female.

Food plant.—Potato (*Solanum tuberosum*).

Notes.—I originally took with some hesitation the species referred to as *Rhopalosiphum solani* (Entomologist, xlv, 1912, p. 165) to be Kaltenbach's species, as it answered in all respects save the shape of the cornicles. I now find there is a true Macrosiphum exactly answering to his description, and generally resembling the common *Rhopalosiphum* found on potatoes, which must be given a new name. I have not found this species myself, but apterae were sent me by Mr. Britten on the 11th of August, 1912. Kaltenbach records it from July to August, and only describes the apterous female.

40. **Macrosiphum dirhodum** (Walker).

Aphis dirhoda, Walker,
Siphonophora dirhoda, Buckton.

Anns. Nat. His., Ser. 2, vol. iii. p. 43, Walker; Mono. Brit. Aph., I, p. 132, pl. xiii (*bis*), Buckton.

Apterous viviparous female.—Green to greenish-yellow, oval; eyes deep red; apex of abdomen sometimes clouded with brown.

Antennae not as long as the body,[1] arising from small but distinct frontal tubercles, green, the last segment brownish, the third segment longer than the fourth, the fifth is usually as long as the fourth,[2] the sixth short, not quite as long as the fourth and fifth combined.

Cornicles pale greenish-yellow, imbricated, in many dusky at the tip. Cauda pale yellowish-green, moderately long, blunt at the apex.

Legs rather short and slender, yellowish-green, with dusky tarsi. In some the antennae are dusky at the apices of the third to fifth segments.

Length.—2.5 to 3 mm.

Alate viviparous female.—Green to yellowish-green, thorax buff colour, with pale brown thoracic lobes. The abdomen has either a dusky green stripe or a row of dusky spots. The antennae are nearly

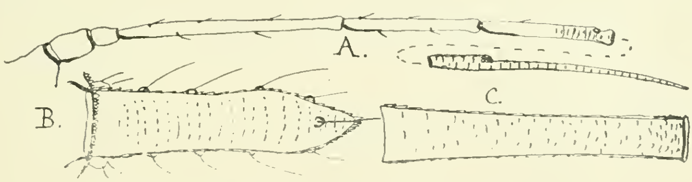


Fig. 40.—*Macrosiphum dirhodum* (Walker).
A, Antenna; B, Cauda; C, Cornicle of apterous viviparous female.

as long as the body, brownish-green at the base; the eyes are brown, and the proboscis green with a brown tip. Cornicles and cauda green. Legs dull yellowish to pale green, tips of the femora and tibiae and tarsi brown. Wings with brown veins, yellowish-brown insertions and brown stigma. It is subject to much variation. Walker described two marked varieties, one with black feelers as long as the body, nectaries pale green, with black tips—found in the autumn. The second he describes as "Pale yellowish-green; the lobes of the chest and breast dark grey; feelers are green at the base, and longer than the body; the other limbs are pale yellow; the tip of the mouth, eyes, and tip of nectaries black, the latter nearly one-fourth the length of the body; knees, feet and tips of the shanks black; wing-rib and rib-veins pale yellow. In the autumn, when the winged females abound on the rose leaf, and each of them is surrounded by a group of its white or pale green little ones."

[1] Walker says one-fourth the length of the body, clearly an error.

[2] Walker says shorter than the fourth.

Length.—2 to 2.5 mm. *Wing expanse,* 7 to 7.5 mm.

Male.—Alate. Buff, head and disc of thorax and venter brown. Abdomen with a black line along the back and a row of black dots on each side; the antennae are black, dull buff at the base, and much longer than the body; rostrum pale, dark at the tip; eyes black; cornicles pale buff, with dusky tips; legs pale yellow, tips of femora and tibiae and tarsi black. Veins of wings yellow, stigma brown. Cauda buff.

Length.—1.8 to 2 mm. *Wing expanse,* 7 to 7.5 mm.

Walker describes two varieties:—

1. Pale orange; the head, disc of chest and that of the breast black; feelers pale, orange towards the base; eyes dark red; nectaries dull brown, and as long as one-fourth of the body; thigh, excepting the base, black.

2. The nectaries yellow, with black tips.

Ovigerous female.—Apterous; pale lemon colour, head almost white, eyes red, legs almost white; antennae pallid, dark at the apex; cornicles pale, dusky at the tip. Legs pale, tips of femora, tibiae and all the tarsi dusky.

Walker describes six varieties:—

1, green; 2, pale straw colour; 3, buff; 4, light buff, varied with pale red; 6, saffron; and 7, orange.

Buckton describes it as delicate green.

The hind tibiae are flattened and show numerous sensoria.

Length.—1 mm.

Localities.—Hollington, Ecclesbourne, Rye, Colemans Hatch, Sussex; Wye, Tonbridge, Faversham, Tenterden, Ramsgate, Ashford, Canterbury, Kent; Esher, Godalming, Mitcham, Kingston, Churt, Haslemere, Surrey; Cambridge; Great Staughton, Hunts.; Fowey, Falmouth, Cornwall; Budleigh Salterton, Exeter, Lynton, Devon; Worcester; Hereford; Chepstow; Monmouth; Great Lalkeld, Penrith; Criccieth, North Wales; and Filey, Yorks; Wanstead (Buckton).

Food plants.—All varieties of cultivated roses and the wild *Rosa. Polygonum persicaria* (Buckton). Wheat and grasses (Walker).

Notes.—An abundant rose pest, probably occurring all over Britain and Europe. One can find the apterae from April to November, but I have not been able to obtain any alatae or sexuparae, yet I have had it under observation for some years, as late as November 2nd. I have had pupae sent me in June from Hereford. It also seems to occur on wheat and barley. There seems to be a migration between the rose and *graminaceae.*

41. Macrosiphum pelargonii (Kaltenbach).

Aphis pelargonii, Kaltenbach.
Siphonophora pelargonii, Koch and Buckton.
Aphis pallida, Walker.

Mono. Pflanz., p. 21, Kaltenbach; Die Pflanz., p. 193, figs. 265, 266, Koch Ann. Nat. Hist., Ser. 2, II, p. 430, 54, Walker; Mono. Brit. Aph., I, p. 136, pl. xv, Buckton.

Alate viviparous female.—Green; the head and thoracic lobes sometimes pale brownish-yellow. Antennae longer than the body, greenish-yellow, last segment brownish, third segment with a row of thirteen to sixteen sensoria, reaching nearly to the end of the segment, fourth a little shorter than the third, fifth a little shorter than the fourth, the sixth not quite as long as the fourth and fifth. Eyes deep red to black. Cornicles long and thin, pale green, dusky at the apex; on the apex some irregular transverse striae and cross lines, the rest faintly imbricated. Cauda pale yellowish-green, rather long.

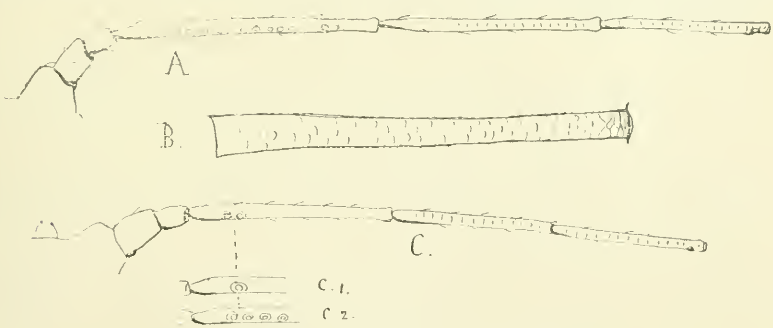


Fig. 41.—*Macrosiphum pelargonii* (Kaltenbach).
A and B, Antenna and cornicle of alate female; C, Antenna of apterous female showing variations in sensoria.

Legs rather long, pale yellowish-green, with dusky apices to the femora and tibiae, and dark tarsi. Wings with pale yellowish-brown insertions, cubitus and stigma.

Length.—2 to 2.3 mm. *Wing expanse*, 8 mm.

Apterous viviparous female.—Pale yellowish-green; elongated oval. Antennae very long, longer than the body, apices of the segments dusky, a dusky patch around the group of sensoria on the sixth segment, which is dusky at the apex; on the third segment are one to four sensoria near the base, and it has a few short pale hairs arising from distinct tubercles over its surface. Cornicles pallid, long and thin, ornamented as in the alate form. Legs pale yellowish-green, the apices of the tibiae and the tarsi dusky, a few hairs on the

femora, many on the tibiae. Proboscis dusky just at the apex, reaching past the second pair of legs.

Length.—2 to 2.3 mm.

Localities.—Widely distributed over Britain, especially in greenhouses, but also in the open.

Food plants.—Geraniums, Calceolarias, Chrysanthemums, Cinerarias, Arum Lilies, Malvas, Persimmon, under glass. *Malva sylvestris*, Chrysanthemums and Geraniums in the open. *Mespilus germanica* (Buckton).

Notes.—Essentially a glasshouse species with *M. circumflexum*, but also occurs out of doors. Buckton records it as occurring on Chrysanthemums out of doors up to December 25th. I have never found any sexuparae. Under glass asexual viviparous reproduction continues all the year.

Koch, however, notices a flesh-coloured winged variety, which may have been the male.

Walker's *Aphis pallida* is this insect.

42. **Macrosiphum urticae** (Schrank).

Aphis urticae, Schrank.
Siphonophora urticae, Koch and Buckton.
Siphonophora carnosa, Buckton (var.).

Fn. Boica., II, p. 106, n. 1188, Schrank; Mono. Pflanz., p. 13, Kaltenbach; Die Pflanz., p. 154, figs. 208, 209, Koch; Mono. Brit. Aph., I, p. 143, pl. xix and xx.

Alate viviparous female.—Shiny green; the head, prothoracic band, thoracic lobes and scutellum black. Eyes red. Antennae longer than the body, dark, first two segments and base of the third pale greenish; third segment with 28 to 32 sensoria, mainly along one side. Abdomen showing three more or less distinct black lateral spots. Cornicles long, thin, cylindrical, but expanded just at the base, green, in some with dusky apices, just at the apex is some transversely expanded reticulation, remainder faintly imbricated. Legs yellowish-green, apices of the tibiae and tarsi dusky, tibiae with many hairs, femora with a few shorter ones. Wing insertions pale green, stigma pale brown.

Length.—3 to 3.5 mm. *Wing expanse,* 11 to 11.5 mm.

Apterous viviparous female.—Green, rather shiny; pyriform. Eyes reddish-brown. Antennae as long, or longer, than the body, green, with the apices of the third, fourth and fifth segments dusky, the sixth dusky; frontal tubercles large; third segment with three sensoria close together near the base; a few hairs on the segments. Cauda elongate, green. Cornicles very long, green, thin, and cylin-

drical, slightly expanded at the base, the apex with a few large transversely elongated reticulations, rest faintly imbricated.

Legs green to yellowish-green, apices of the tibiae and the tarsi dusky; femora, and especially the tibiae, hairy.

Length.—3.3 to 3.8 mm.

Localities.—Chandlers Ford, New Forest (4/19/12); Duffield; Wye, Kent (29/6/04; 7/7/09; 3/6/10; 17/6 and 24/8/12); Westwell,

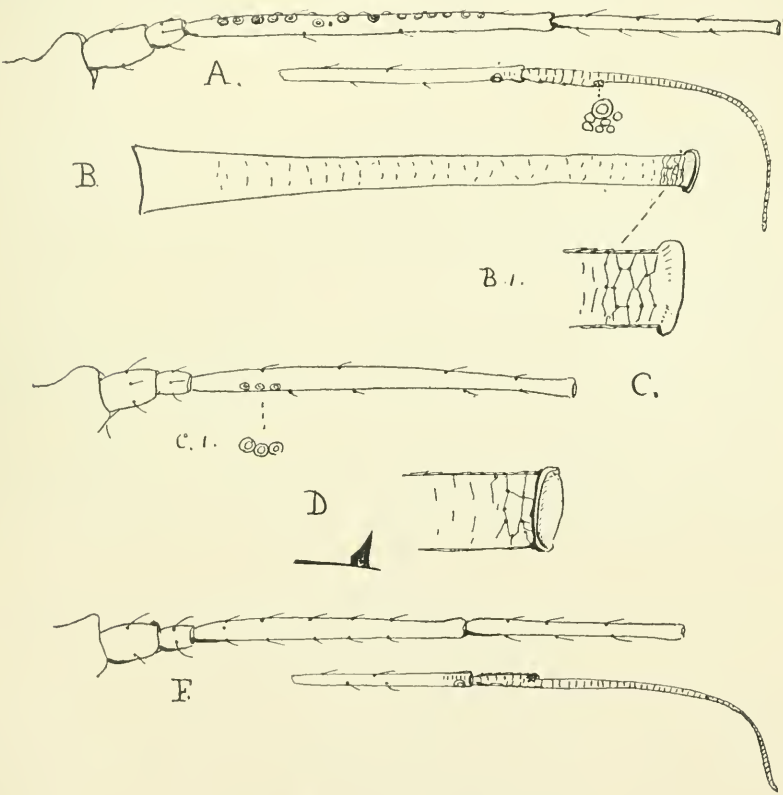


Fig. 42.—*Macrosiphum urticae* (Schrank).

A and B, Antenna and cornicle of alate female. C, Antenna of apterous female; c.i., sensoria; D, Apex of cornicle of apterous female; F, Antenna of larva.

Ashford, Whitstable and Tunbridge Wells, in Kent; Ventnor, Isle of Wight (2/5/11); Ealing (2/6/84); Hastings (4/6/88); Cambridge (7/5/89); Criccieth, N. Wales (7/8/01); Fowey, Cornwall (7/5/08); Kingston-on-Thames (7/84); Okehampton and Teignmouth, Devon 7/5/08).

Probably found everywhere in Britain.

Food plants.—Urtica dioica; Geranium, sp. Walker also gives as food plants *Malva sylvestris, Geranium robertiarum*, and *Chelidonium majus.*

I have only found it on the stinging nettle, with a single exception of two possibly stray apterous females on a *Geranium*, sp.

Notes.—This very common species may be found on the stinging nettle from the end of April, through to November, and in mild winters it may continue to live and reproduce through into the spring. It frequently appears in vast numbers, notably in 1884 and 1911. So far I have been unable to find any sexuparae.

There is some variation in colour in the apterae, some are all green, others show darker stripes down the body, and some are deeper coloured than others, and some farinose. The structure of the cornicles and antennae in all forms is, however, well marked.

Schouteden places Buckton's *Siphonophora carnosa* as a variety of this species; as far as I can see it is quite similar in structure, but appears later in the year.

Buckton describes two varieties of the apterous form of *urticae*, the typical one described here and var. B. as being "Dull, somewhat hoary, punctured. No green dorsal or lateral stripes. Not pilose."

Colonies of *urticae* are easily seen by the quantities of white exuviae on the upper surface of the nettle leaves.

I have noticed that in May great numbers of *Bibionidae* are attracted to their honey-dew, which they imbibe from the leaves.

43. **Macrosiphum pisi** (Kaltenbach).

Aphis pisi, Kaltenbach.
Siphonophora pisi, Koch and Buckton.
Nectarophora destructor, Johnson.
Aphis pisum, Harris.
Nectarophora pisi, Sanderson.
Aphis lathyri, Mosley—Walker.
Aphis onobrychis, Boyer.

Mono. Pflanz., p. 23, Kaltenbach; Die Pflanz., p. 190, figs. 261, 262, Koch; Mono. Brit. Aph., I, p. 134, pl. xiv. Buckton; Gard. Chron., I, p. 684, Mosley; Cat. Hom. B. M., iv, p. 966, Walker; Exposit. Engl. Ins., 66, pl. 17 figs. 10-12 Harris: Ann. Ent. Soc. Fr., x, p. 169, 9, Boyer.

Alate viviparous female.—Green of various shades, some very pallid, others apple green to grass green, sometimes with a slight mealy coat, at others shiny. Eyes from deep red to black. Antennae very long, pale yellowish-green, apices of the segments dark, sixth mostly dark, sometimes olive-green, at others yellowish-green, fourth

segment not quite as long as the third, the third with a line of 12-16 sensoria, not reaching the apex, fifth about as long as the fourth, sixth as long as the fourth and fifth together, all the segments faintly striate. Cauda long and ensiform, but not so long as in the apterous female as a rule. Cornicles long and cylindrical, as long as the cauda, pale green to yellow green, dusky at the apex, imbricated for their whole length. Legs green, with dusky apices to femora and tibiae, and dusky tarsi. Wings with yellowish stigma, varying to yellowish-green. In some specimens the thoracic lobes are slightly darkened.

Length.—2.5 to 3 mm. *Wing expanse*, 9 to 9.4 mm.

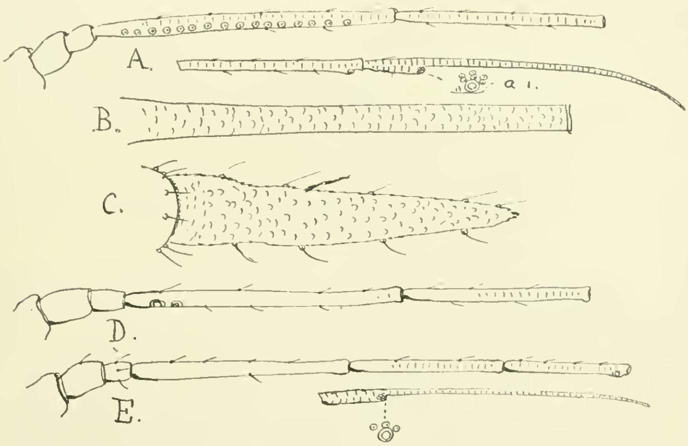


Fig. 43.—*Macrosiphum pisi* (Kaltenbach)
A, B, C, Antenna, cornicle and cauda of alate female; D, Antenna of apterous female; E, Antenna of nymph.

Apterous viviparous female.—Green, spindle-shaped, elongate and smooth, somewhat shiny as a rule, but now and then glaucous. Eyes red. Abdomen sometimes showing six darker spots on each side. Legs green to yellowish-green, marked as in alate form. Cauda ensiform and long. Antennae very long, pale yellowish-green, marked as in the alate female, fourth segment about three-fourths the length of the third, fifth not quite as long as the fourth, sixth as long as four and five together; the third has two sensoria at the base. Cornicles pale green, dusky at the apex, long and thin, but not reaching beyond the tail, imbricated along their whole length.

Length.—2.2 to 3 mm.

Pupa.—Much like the apterous female, wing-cases dusky at their apices, and there is now and then some darker mottling and a darker

green dorsal line. Like the former stage, the skin may carry a mealy covering. Third antennal segment with no sensoria, cauda shorter and broader than in the other forms.

Male.—Alate. " Dorsal aspect of head yellowish, ocelli black, eyes red, mesal line darker, a dark spot either side of meson caudally; ventral aspect, head and thorax yellow, except mesosternum, which is deep olive brown to blackish, shining, chitinous; rostrum reaches to centre of mesenteron; prothorax dorsally yellowish-green, thoracic dorsal patch dark olivaceous to blackish; legs yellowish or reddish-brown, tips of femora and tibiae and tarsi black; large blackish pleural spot on either side of mesothorax, and two smaller spots caudad of it at bases of meso- and meta-coxae. Abdomen light green, slightly whitish pulverulent, three or four lateral blackish spots cephalad of cornicles; cornicles green, tips black; cauda green; irregular horizontal spots on either side of abdomen around pores of connexivum above spiracles.

Length.—2.5 mm. *Wing expanse*, 9 mm." (Sanderson.)

Localities.—General over Britain and Continental Europe and America.

Food plants.—All cultivated culinary and ornamental peas (*Pisum*), wild Everlasting Pea (*Lathyrus sylvestris*), Red Clover (*Trifolium pratensis*), White Clover (*T. repens*), Alsike (*T. hybridum*), Shepherds' Purse (*Capsella bursa-pastoris*).

Life-cycle.—This so-called Green Dolphin or Destructive Green Pea Louse usually appears on garden and field peas late in June and early July, and goes on until the end of August and mid-September. The winged females leave the dying peas and fly to Clovers and Everlasting Peas (*Lathyrus*), where they produce sexuparae. The ova I found were laid low down on the haulm, but now and then on any part of it. At first the eggs are green, then become shiny black. In 1907 I found they hatched on March 27th. The same happens on the clovers, where the majority hibernate and live until they migrate to the peas and set up the summer broods of apterae and alatae. Colonies now and then occur on the Shepherd's Purse, but I have never known them survive any length of time. Unfortunately, I did not preserve the oviparous females I found in 1907, and have never found a male, so have added Sanderson's description of it.

A full account of the various synonyms given of this species will be found in the Report of the Second International Congress of Entomology.

44. **Macrosiphum ulmariae** (Schrank).

Aphis ulmariae, Schrank.

Fn. Boica, II, p. 111, n. 1221, Schrank.

Alate viviparous female.—Various shades of green, sometimes with a glaucous coat. Head, antennae and cornicles slightly darker than in *pisi*. The green legs have a larger dark area at the apices of femora and tibiae, and darker tarsi. Cornicles relatively thicker than in *pisi*, and their dusky apices are markedly reticulate. The third antennal segment has a line of 14 to 18 sensoria on one side, remaining segments without sensoria except the normal one of the fifth and those on the sixth.

Length.—2 to 3 mm. *Wing expanse*, 9.2 to 9.8 mm.

Apterous viviparous female.—Pale green of various shades, often with a mealy coat. Antennae as long as the body, apices of third, fourth and fifth segments dusky, fourth slightly shorter than

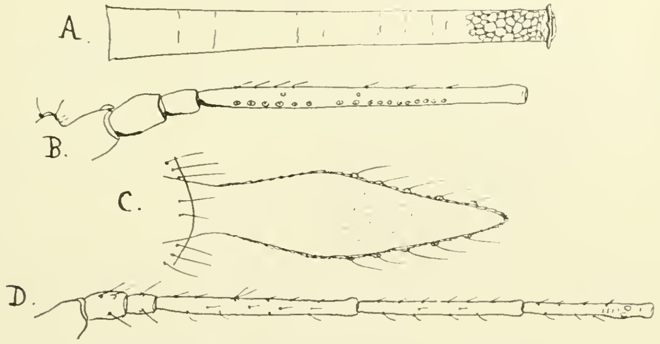


Fig. 44.—*Macrosiphum ulmariae* (Kaltenbach).
A, Cornicle; B, three basal antennal segments; C, Cauda of alate female; D, antenna of apterous female.

the third, fifth about equal to the fourth, no sensoria on the third. Cornicles green, dusky at the apex, showing no reticulation. Legs all yellowish-green except the tarsi.

Length.—2.5 to 3 mm.

Pupa.—As the above, with slightly dusky wing tips.

Localities.—Many places in Kent, Sussex, Surrey, Hampshire and Huntingdonshire; Great Lalkeld, Penrith.

Food plant.—The Meadow Sweet (*Spiraea ulmaria*).

Notes.—This common species has been confused with *pisi* and *gei*. It differs from the former in its reticulate cornicles in the alatae and in the antennae. It lives in dense clusters up the flower stalks,

usually one closely fixed behind the other. The apterae are very timid and fall to the ground at the least shock. It occurs in greatest abundance from May to June as apterae, and in July alatae occur, and then it decreases and seems to leave the Spiraea. No sexuparae have been seen.

45. **Macrosiphum gei** (Koch).

Siphonophora gei, Koch.

Die Pflanz., p. 171, figs. 234, 235, Koch.

Alate viviparous female.—Green to dark green; very similar in general appearance to the former species; the legs are darker, and there is a dark area at the apex of the femora and tibiae, and the tarsi are dark. Thoracic lobes sometimes darkened. The ensiform cauda green.

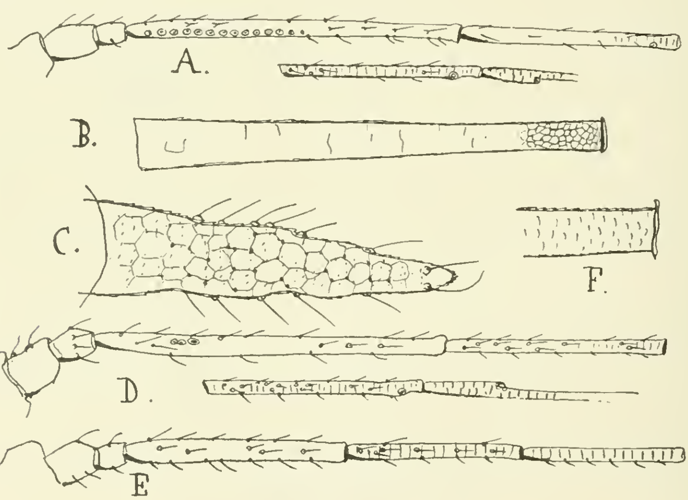


Fig. 45.—*Macrosiphum gei* (Koch).

A, B, and C, Antenna, cornicle and cauda of alate female; D, Antenna of apterous female; E and F, Antenna and apex of cornicle of nymph.

Cornicles green, with dusky reticulate apex, and below a few transverse lines. Third segment of antennae with 14 to 16 sensoria in a line, extending for rather more than half the length of the segment, none on the remainder.

Length.—2.5 to 3 mm. *Wing expanse*, 9 mm.

Apterous viviparous female.—Cornicles the same as in the alate female, dusky at the apex. Third segment of the antennae with three sensoria near the base. Green, and legs similar to alate female.

Length.—2.5 to 3 mm.

Pupa.—Cornicles imbricated for their whole length, and darker than in the other two stages. No sensoria on segment three of the antennae. Wing-buds dark brown.

Localities.—Kent, Surrey, Sussex, Essex, and Hampshire, in many places; Ventnor, Isle of Wight; Little Hadham, Hertfordshire.

Food plant.—The Wild Avens (*Geum urbanum*).

Notes.—Found in dense clusters up the flower-stalks of the wild Avens, closely packed together, as in the former species. They readily fall if the plant is touched. It appears in April, and continues through June. Nymphae appear the end of May and alatae in June. By the first week in July they commence to leave the Geum, and by the second week scarcely any can be found, but a few occur up to August. The other host plant is not known. It is a distinct species, but has been placed as a synonym of *ulmariae* with *pisi*.

46. **Macrosiphum trifolii**, n. sp.

Apterous viviparous female.—Very similar in general appearance to *M. pisi*, but usually a paler green. The antennae are relatively thicker, the fourth segment not as long as the third, the fifth as long as the fourth; no sensorium on the third.

Length.—2.5 mm.

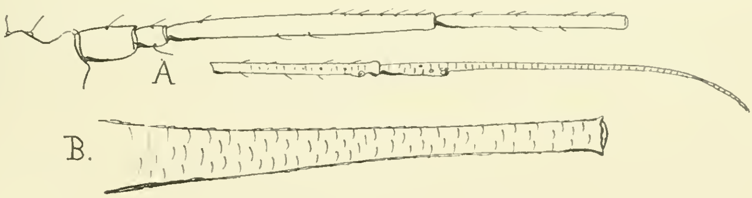


Fig. 46.—*Macrosiphum trifolii*, n. sp.
A, Antenna, and B, Cornicle of apterous female.

Locality.—Wye, Kent.

Food plant.—*Trifolium procumbens*.

Notes.—Found in August in small numbers, breeding amongst flower-heads. I was unable to obtain alatae. They continued until mid-September, reproducing very slowly.

47. **Macrosiphum loti**, n. sp.

Alate viviparous female.—Green, the thoracic lobes slightly darkened; antennae brown, except the two basal segments, and just the base of the third, as long or longer than the body, the third seg-

ment with five to six sensoria on the basal half in a line, fourth segment a little shorter than the third, fifth a little longer than the fourth, sixth short, about half as long again as the fifth. Eyes black and red. Proboscis yellow, dusky at the tip, not quite reaching to the second pair of legs, cornicles long, pale green, imbricated, with two striae at apex; cauda pale green to yellowish, long, with three pairs of marked lateral chaetae, and two or more terminal ones. Legs yellowish-green, apices of tibiae and the tarsi brown, tibiae with short hairs. Wings with pale yellowish insertions, pale brown stigma and veins.

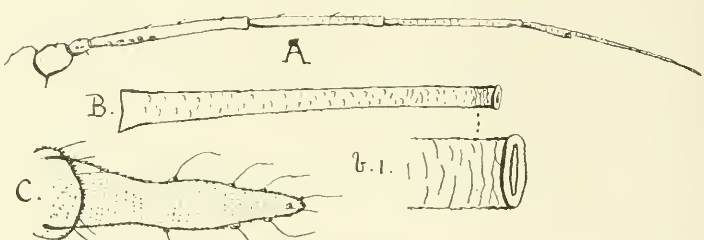


Fig. 47.—*Macrosiphum loti*, n. sp.
A, Antenna; B, Cornicle, further enlarged apex (b.i.); C, Cauda of alate female.

Length.—2 to 2.2 mm. *Wing expanse*, 7 mm.

Apterous viviparous female.—Similar in colour to *M. pisi*, but the cornicles are relatively much longer and thinner; the cauda shorter, and the third segment of the antennae has one to three reniform sensoria near the base. Three marked pairs of lateral caudal setae.

Length.—2 mm.

Locality.—Wye, Kent; and Great Lalkeld, Penrith; Bulverhithe, Hastings.

Food plant.—Bird's Foot Trefoil (*Lotus corniculatus*).

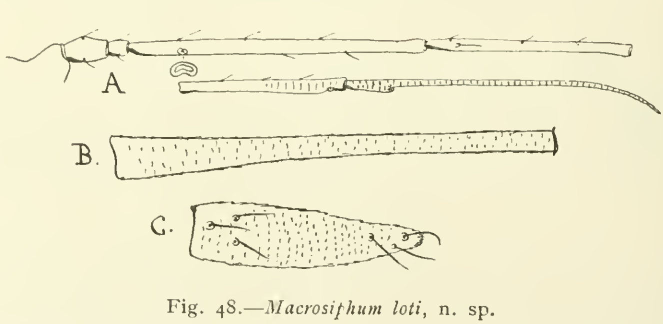


Fig. 48.—*Macrosiphum loti*, n. sp.
A, Antenna; B, Cornicle, and side view of cauda; C, of apterous female.

Notes.—A few specimens taken in May near Hastings, and in July and August at Wye. Alate females and apterae were sent me in June from Great Lalkeld by Mr. Britten. One apterous female taken at Wye has abnormally long cornicles. When removed from the Bird's Foot Trefoil to Peas, in July, I failed to induce this species to breed; in a day they had fallen or crawled off and were hastening away.

48. **Macrosiphum stellariae**, n. sp.

Alate viviparous female.—Head brown; eyes black; stemmata dark. Antennae blackish, base olive, base of third segment pale; third segment with 16 to 20 sensoria on the basal two-thirds. Pronotum green with two dark olive areas. Thorax green with black lobes and a black spot at the sides in front of the wing insertions; metathorax with black markings; mesosternum black. Abdomen

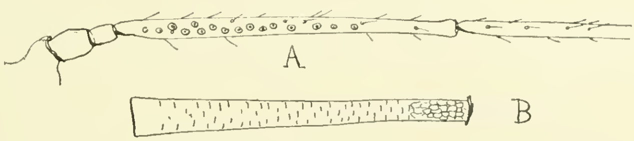


Fig. 49.—*Macrosiphum stellariae*, n. sp.
A and B, Antenna and cornicle of alate female.

bright green with darker mottlings. Cornicles very long and thin, pale green, dusky at the apex, which is reticulate, remainder strongly imbricated. Legs yellowish-green, apices of femora dark, most of the tibiae dark and all the tarsi.

Length.—2.5 to 3 mm. Wing expanse, 8 to 9 mm.

Apterous viviparous female.—Pale green to apple green; very like *M. pisi*, but the antennae not so long, and the cornicles thicker.

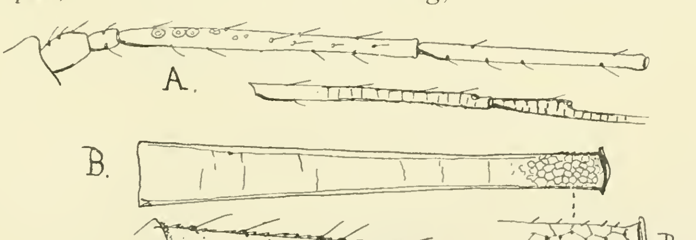


Fig. 50.—*Macrosiphum stellariae*, n. sp.
A, B, C, Antenna, cornicle and cauda of apterous female; B.I. further enlarged apex of cornicle.

Cornicles green, with dark apices, which are reticulate, remainder with a few transverse striae. Third segment of the antennae has a group of five or six sensoria near the base, and the fifth and sixth segments are dusky.

Length.—2.5 mm.

Localities.—Ecclesbourne Glen and Hollington, Hastings; Ventnor, Isle of White; Wye, Kent; Great Lalkeld, Penrith; Bramley, Surrey.

Food plant.—The Stitchwort (*Stellaria graminea*).

Notes.—This species lives in the terminal tuft of leaves and the unopen flower-heads of the Stitchwort, a few only on each plant, in the early part of the year. I found it generally distributed in May in Ecclesbourne Glen, a few at Ventnor, and two specimens only at Wye. On the 20th of May I found countless numbers of alatae and apterae at Bramley in 1913. In July it was found at Great Lalkeld, Penrith (Britten). It seems to retard the opening of the heads, and in some produces a marked swollen appearance, if present in any numbers in the early part of the year.

49. **Macrosiphum crataegarium** (Walker), (non Buckton).

Ann. and Mag. Nat. Hist., p. 46, vi, sec. ser., Walker.

Apterous viviparous female.—Green to yellowish-green; antennae pale brown except at the base; tarsi brown. Eyes black or red. Antennae a little longer than the body, the third segment a little longer than the fourth, the fourth a little longer than the fifth, the sixth not quite so long as the fourth and fifth together. Two marked,

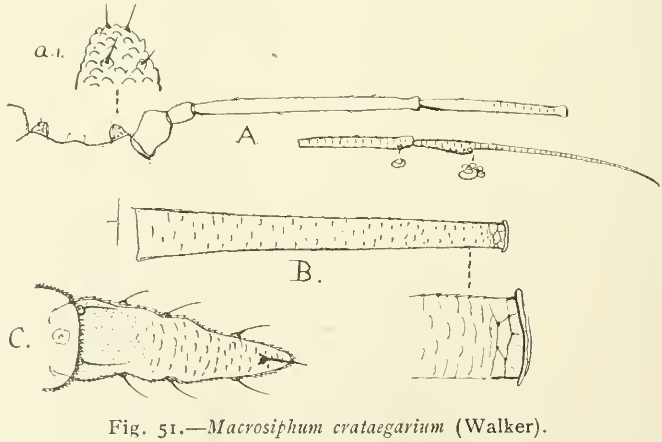


Fig. 51.—*Macrosiphum crataegarium* (Walker).
Apterous viviparous female. A, Head and antenna; A.I. frontal process; B, Cornicle; C, Cauda.

blunt tubercles projecting forwards on the head. Cornicles long, cylindrical, pale green, a few large reticulations at the apex, remainder finely imbricated. Cauda pale green, rather long.

Legs pale green, tarsi dusky brown, apices of the tibiae slightly darkened, a few short, fine hairs on the tibiae. Proboscis reaching nearly to the third coxae.

Length.—1.5 to 2 mm.

Alate viviparous female.—"The body is rather large and grass green; the head and the disc of the chest and that of the breast reddish-brown; there is a row of black spots on each side of the abdomen; the eyes and the feelers are dark brown, and the latter are a little longer than the body; the mouth is pale green, with a brown tip; the nectaries are pale green, and as long as one-fourth of the body; the legs are long and pale yellow; the feet and the tips of the thighs and of the shanks are brown; the wings are colourless; the wing-ribs are pale yellow; the brands are very pale brown; the veins are brown. 1st var., The feelers and the eyes are black, and the former are dull green at the base; the tip of the mouth is black; the legs are pale green; the knees, the feet, and the tips of the shanks are black; the wing-ribs are pale green."

Localities.—Wye, Kent (7/6/11 and 1/7/11); Widdington, Essex (14/6/12); Guildford, Surrey (17/5/13).

Food plant.—Hawthorn (*Crataegus oxyacanthae*).

Notes.—A very marked species, at once told by the curious tubercles on the head at the base of the antennae. It occurs in masses on the tips of the young shoots and under the top leaves. I failed to breed alate forms, so append Walker's description. Buckton (Mono. Brit. Aph. II, p. 37, pl. xlvii, fig. 4) redescribes the apterous form of an Aphis under this name. It is certainly not Walker's species, which is Macrosiphum. Walker distinctly states the antennae are longer than the body, and the cornicles pale, important points which Buckton ignored.

50. **Macrosiphum sileneum**, n. sp.

Apterous viviparous female.—Pale green. Eyes red. Antennae considerably longer than the body, thin, green, apices of third, fourth and fifth segments and all the sixth dark brown; third segment a little longer than the fourth, fifth a little shorter than the fourth, sixth not quite as long as four and five; the third has four sensoria in a line near the base, all the segments but the sixth with a few small pale hairs; frontal tubercles large. Proboscis yellowish-green, broad, dusky just at the apex, reaching past the second coxae.

Legs long and thin, pale green, apices of tibiae and all the tarsi dusky, pale short hairs on the femora and tibiae. Abdomen with a few pale short hairs, arising from small tubercles. Cornicles long, thin, slightly expanded basally, green, with deep brown apices, apices reticulate over the dark area, remainder faintly imbricated. Cauda pale green, long and narrowish, with four large hairs on each side, the apical four curved at the tips.

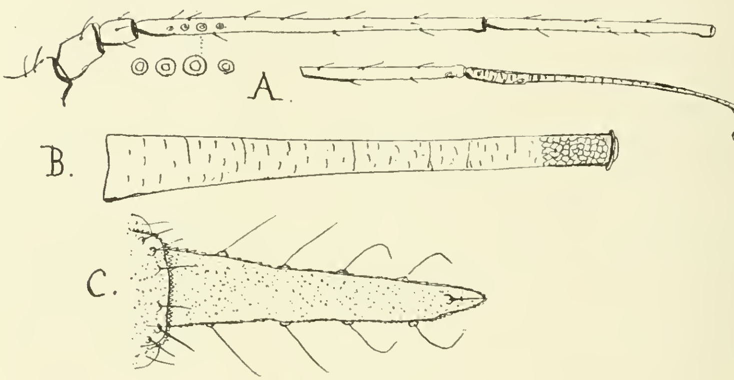


Fig. 52.—*Macrosiphum sileneum*, n. sp.
A, Antenna; B, Cornicle, and C, Cauda of apterous viviparous female.

Length.—2.8 mm.

Locality.—Wye (10/7/11 and 14/8/12).

Food plant.—*Silene inflata.*

Notes.—Found as single specimens feeding inside the flowers of *Silene inflata.* Apparently very scarce, and reproducing very slowly. A single female kept only gave rise to four young in two weeks. The cornicles are very dark at the apex, and the antennal sensoria are marked. I failed to obtain any alate brood.

51. **Macrosiphum arundinis,** n. sp.

Alate viviparous female.—Head and thorax ochreous, the head with two small black stemmata at the base of the antennae near the black eyes. Thorax with three brown areas, one in front, two behind. Abdomen pale green, with a dark green median line. Legs and antennae dark, the latter paler at the base and darkened at the apices of the segments. The legs pale brown, tarsi and apices of tibiae dark. Cornicles pale, moderately long and cylindrical, imbricated. Antennae as long as the body, the third segment with 24 to 30 sensoria over the whole length, situated mainly on one side; all the

segments from the third imbricated. Frontal tubercles moderately developed. Cauda pale yellow, moderately long, blunt, and expanded at the base.

Wings with pale brown stigma and veins.

Length.—2.5 mm.

Apterous female.—Pallid green all over except the tarsi. Eyes black and red. Proboscis not quite reaching the second pair of legs, pallid. Antennae not quite as long as the body, the apex of the fifth and sixth segments dusky, a few small hairs. Cornicles dusky at the tips.

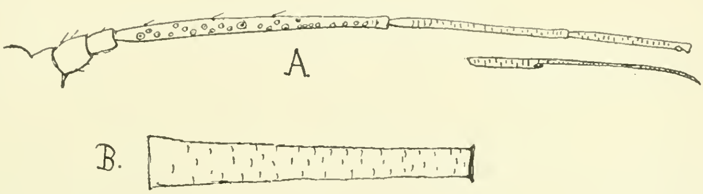


Fig. 53.—*Macrosiphum arundinis*, n. sp.
A, Antenna, and B, cornicle of alate female.

Length.—2 mm.

Locality.—Wye (8/12).

Food plant.—*Arundo phragmitis.*

Notes.—A colony found in August, consisting mainly of alate viviparous females and a few apterae. A delicate pale green species with darkened thorax, antennae and legs that I cannot find described.

52. **Macrosiphum graminum**, n. sp.

Apterous viviparous female.—Uniformly pale green, semi-transparent and very fragile. Eyes large, black. Antennae longer than the body, thin, green to pale yellowish-green, last segment dusky and also the apices of the third, fourth and fifth; the third segment the longest, about as long as the fourth and fifth together, fourth and fifth about equal in length; on the third segment is a single sensorium at the base, sixth segment longer than the fourth and fifth, all the segments faintly imbricated, the third with three or four small pale hairs.

Proboscis dusky at the apex, reaching to the base of the second pair of legs. Cornicles pale, semi-transparent green, cylindrical, slightly dusky at the apex, faintly imbricated. Cauda semi-transparent, large.

Legs semi-transparent, pale green, with dusky tarsi; femora rather broad, with short, fine hairs; tibiae long, with numerous thorn-like, slightly darker, short spines all over them.

Length.—1 to 1.5 mm.

Food plants.—Wild grasses (Meadow Foxtail and Timothy grass).

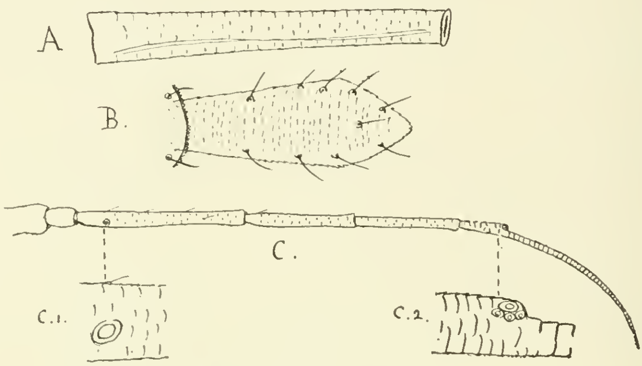


Fig. 54.—*Macrosiphum graminum*, n. sp.

A, Cornicle; B, Cauda, and C, Antenna of apterous female; C.1. and C.2. further enlarged sensoria.

Locality.—Wye, Kent, 23rd of July, 1911.

Notes.—Only apterae could be found in small colonies here and there with many young. No alate forms appeared, and the colonies died out in August. A very fragile green species, some being almost transparent.

53. **Macrosiphum agrostemnium**, nov. nom.

Siphonophora cichorii, Buckton (part) non. Koch.

Mono. Brit. Aph. I, p. 163, pl. xxix, fig. 1.

Buckton describes an olive green aphis with the dorsum studded with dark tubercular spots, long, thin, green cornicles and a reddish-fawn-coloured winged female with black cornicles, from the corn-cockle (*Agrostemma githago*) in June from Haslemere. He considers this Koch's *S. cichorii* from *Cichorium intybus*. It certainly does not agree with Koch's species, which, as pointed out by Kaltenbach (Die Pflanz., p. 328), is *serratulae* of Linnaeus. Moreover, Buckton evidently describes two species under this name.

The green apterous form has priority, for this I propose the name *Macrosiphum agrostemnium*.

54. **Macrosiphum githargo**, nov. nom.

Siphonophora cichorii, Buckton (part) non Koch.

Mono. Brit. Aph., I, p. 163, pl. xxix, fig. 2.

The alate female described by Buckton as *Siphonophora cichòrii*, Koch, is certainly distinct from the green apterous form which he describes under the same name.

The winged female he describes is: "Entirely fine reddish-fawn colour. Very smooth and shining. Tail, femora and wing insertions fine yellow. Antennae, tibiae, tarsi and cornicles black. Cubitus and stigma pale. Veins very delicate. The sides of the insect covered with a greyish bloom."

I have three Marcrosipha from *Cichorium intybum*, but as yet have not worked them out.

55. **Macrosiphum rubiellum**, nov. sp.

Alate viviparous female.—Head brown. Antennae brown to black, the third segment with 13-15 sensoria in a line, along the greater part of its length. Pronotum brownish, with two dark spots. Thorax green with dark brown thoracic lobes and a dark lateral spot in front of the wing insertions, two blackish curved lines behind. Abdomen green to almost yellow, with black lateral spots and paired lines on the dorsum; with four pairs of lateral papillae. Nectaries long, black, cylindrical, and reaching beyond the green cauda,

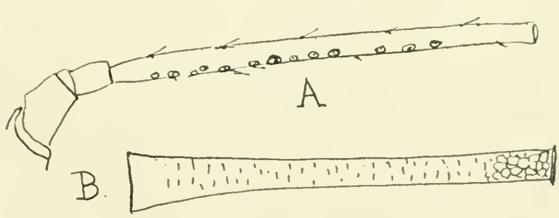


Fig. 55.—*Macrosiphum rubiellum*, nov. sp.
A, Base of Antenna of alate female, and B, Cornicle.

reticulate at the apex, rest imbricated. Legs green, apices of the femora and tibiae and all the tarsi black. Wings with yellow insertions and brownish-grey stigma. Cauda long, green, ensiform, with five pairs of lateral hairs and a sub-apical curved one.

Length.—2.5 to 3 mm. *Wing expanse,* 8 mm.

Apterous viviparous female.—Green to pale yellowish-green. Antennae as long or longer than the body, yellowish-green, sixth segment brownish, and brown apices to the fourth and fifth

segments; the third, which is the longest, has a single basal sensorium. Cornicles long, thin, green, dusky at the apex, slightly expanded basally with a few large hexagonal reticulations and others at the apex, remainder faintly imbricated. Cauda pale yellowish-green, rather short. Legs yellowish-green to pale green; tarsi dusky; femora with a few hairs; tibiae with many short hairs.

Length.—2.5 to 3 mm.

Fig. 56.—*Macrosiphum rubiellum*, n. sp.
Body markings of alate female.

Localities.—Ventnor, Isle of Wight; Wye, Maidstone, Paddock Wood, Ramsgate, Ashford and Tonbridge, Kent; Little Hadham, Herts; Guildford, Woking and Bramley, Surrey.

Food Plants.—Bramble (*Rubus fruticosus*) and Raspberry (*Rubus idaeus*).

Notes.—Described from specimens taken at Little Hadham. It appears to be fairly common on the young shoots and leaves of the Bramble, and I have twice found it on Raspberries. It is possible that Buckton's record of *Siphonophora chelidonii* on Raspberries refers to this species. The specimens were all found in May and June; in the latter month alatae appeared and flew away.

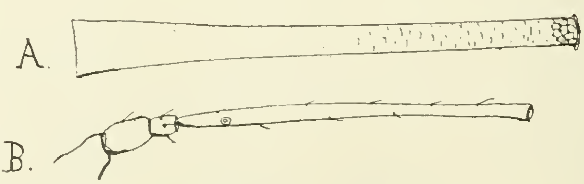


Fig. 57.—*Macrosiphum rubiellum*, n. sp.
Cornicle: A, and part of antenna, B, of apterous female.

56. **Macrosiphum malvae** (Mosley).

Aphis malvae, Mosley.

Gard. Chron. I, 684, Mosley; Ann. Nat. Hist. Ser. 2, ii, 429, 53, Walker; Zoologist, vii, Ap. xlvii, Walker.

Alate viviparous female.—Head reddish-brown; eyes black; antennae longer than the body, dark brown, except the base of the third segment and the two basal segments, which are paler; the third segment a little longer than the fourth, the fourth than the fifth, the sixth a little longer than the fourth and fifth; the third has a nearly uniform line of 23-25 sensoria reaching to about the apex.

Pronotum yellowish-green, dusky at the apex, reaching just to the second pair of legs.

Pronotum dark in the middle; thoracic lobes brown.

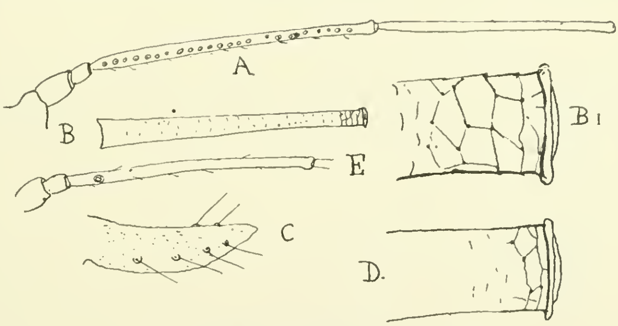


Fig. 57.—*Macrosiphum malvae* (Mosley).
A, B and C Antenna, cornicle and cauda of alate female. D and E, Apex of cornicle and base of antenna of apterous female.

Abdomen green to yellowish-green, with some dark markings. Cornicles long, rather thin, and cylindrical, reaching a long way beyond the cauda; pale yellowish-green, apices dusky; apex with a few large reticulations, remainder imbricated; cauda pale yellowish-green, with four pairs of lateral chaetae. Legs green, dusky at the apices of the femora, a broad, dark brown band at the ends of the tibiae, and dark tarsi, long and thin. Wings large, with pale brown stigma and brown veins.

Length.—2.5 to 3 mm. *Wing Expanse,* 8-9 mm.

Apterous viviparous female.—Green, except the apices of the tibiae and the tarsi and eyes, which are dark. Antennae pale, with a dark area at the joints of the third and fourth and fourth and fifth segments, apex of the fifth brown, and all the sixth; the third segment longer than the fourth, the fourth a little longer than the fifth; a single sensorium near the base of the third.

Cornicles long, thin, yellowish-green, reaching to the end of the pale green cauda; a few faint reticulations at the apex, faint imbrications on the rest; cauda with four hairs on each side.

Length.—2.5 to 3 mm.

Food plants.—*Malva sylvestris* and *Malva sp.*?

Habitat.—Wye (7/6/13).

Observations.—Found on the under-sides of the lower leaves of mallows. Very similar in appearance to *M. pelargonii,* Kaltenbach, but I am sure quite distinct. Probably Mosley's *Aphis malvae* was this species, so have adopted his name, instead of sinking the species under *Pelargonii.*

57. **Macrosiphum potentillae** (Walker).

Aphis potentillae, Walker.

Ann. Mag. Nat. Hist., Vol. vi, Sec. Se. p. 122, 1830.

Apterous viviparous female.—Pale yellow, elliptical. The antennae are a little longer than the body, and arise from marked frontal prominences, the fourth segment shorter than the third, the fifth shorter than the fourth, the sixth longer than the fourth and fifth together; apices of third, fourth and fifth dusky, and all the sixth. Eyes black. Legs yellow; the tips of the tibiae and tarsi dusky. Cornicles yellowish, dusky at the apex, expanded at the tips, cylindrical, about one-fifth the length of the body, showing faint imbrication. Cauda short, triangular. Proboscis yellow, dusky at the tip, reaching to the second pair of legs.

Length.—1.5 to 2 mm.

Food Plant.—*Potentilla anserina.*

Habitat.—Guildford (20/5/13).

Observations.—A few apterae and two nymphae only found on the leaves of *Potentilla.* Walker gives no locality for his *Aphis potentillae.* I feel sure that this is Walker's species, although there is a discrepance in regard to the antennae, Walker saying the fourth joint is much shorter than the third, and that the seventh is twice the length of the sixth; the flagellum of the sixth is much more than twice the length of the basal part in all my specimens, and as such a short flagellum is most unusual, perhaps the antennae of Walker's specimen were broken.

In one specimen the antennae are mostly brown.

The nymphae have yellow wing-cases, and the apices of the antennal segments dusky. Walker says no tube at the tip of the body. This points to an immature female, the same as those described here.

58. **Macrosiphum ranunculinum** (Walker).

Aphis ranunculina, Walker.

List Homop., iv, p. 1046, 1852.

Apterous viviparous female.—Pale yellow, elliptical, narrowed towards the head.

Antennae not quite so long as the body, slender, yellowish, tips of the segments dusky, the sixth brown; arising from moderate sized tubercles; fourth segment a little shorter than the third, which has four sensoria on the base; fifth shorter than the fourth, sixth as long as four and five together. Eyes black. Proboscis yellow, reaching the second pair of legs. Cornicles yellow, dusky at the apex, long, cylindrical, but expanded at the base. Apex with large reticulations, remainder faintly imbricated; cauda long, yellow, with four pairs of lateral hairs; legs long, yellow, apices of the tibiae and the tarsi brown; tibiae with many short stiff hairs.

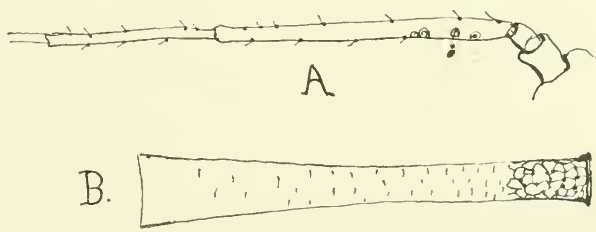


Fig. 58.—*Macrosiphum ranunculinum* (Walker).
A and B, Antenna and cornicle of apterous female.

Length.—2 to 2.5 mm.

Food plant.—*Ranunculus* spp.

Locality.—*Guildford* (20/5/13).

Observations.—Several small colonies on the leaves and up the flower stalks, mostly apterae, but one nymph, which had yellow wing-cases and the cornicles showing no reticulation. It answers to Walker's *Aphis ranunculina*, but the antennae are not a little longer than the body but a little shorter, or the same length, but there is some variation in the relative length in those I found.

Walker gives only England for locality.

59. **Macrosiphum anterrhinum** (Macchiate).

Siphonophora anterrhinum, Macchiate.

Soc. Ent. Ital., xv, p. 228 (1883).

Apterous viviparous female.—Green, slightly glaucous, elongated oval. Antennae a little longer than the body, arising from prominent frontal tubercles, pale yellowish to pale yellowish-green,

sixth segment dusky at the apex and around the basal swollen area, the fourth segment considerably shorter than the third, the fifth slightly shorter than the fourth. Eyes deep red. Proboscis yellowish, dusky at the apex, reaching the third pair of legs. Legs pale yellowish-green; tarsi brown. Cornicles long, somewhat swollen on the apical half, pale yellowish-green, dusky at the apex, imbricated, two or three striae across the dark apex, reaching beyond the cauda, which is pale yellowish-green, with three pairs of lateral hairs, and less than half the length of the cornicles.

Length.—1 to $1\frac{1}{2}$ mm.

Alate viviparous female.—Antennae a little longer than the body, brown, base of third segment pale; third segment with twelve sensoria on one side, extending to nearly the apex; the fourth segment a little shorter than the third, the fifth a little shorter than the fourth, the sixth about as long as the fourth and fifth together; third to sixth striate; frontal tubercles dark and large.

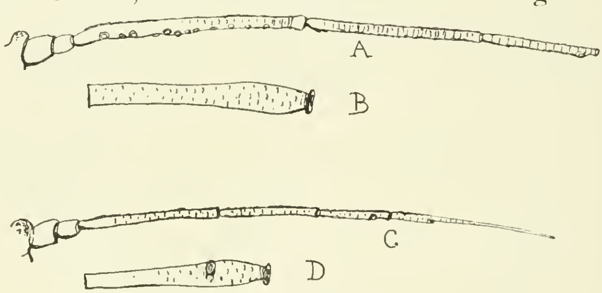


Fig. 59.—*Macrosiphum anterrhinum* (Macchiate).
A and B, Antenna and cornicle of alate female; C and D of apterous female.

Cornicles rather long, dark, slightly swollen on their apical half, imbricated, with a few apical transverse lines; cauda dusky, about half the length of the cornicles.

Length.—2 mm. *Wing expanse*, 6 to 7 mm.

Food Plant.—*Anterrhinums*, both cultivated and wild.

Habitat.—Glasgow, N.B.; Italy (Macchiate); Njoro, British East Africa (16/1/12).

Observations.—Macchiate described the apterous viviparous female of this species from Italy. I have only received it from Glasgow, and undoubtedly the same species from *Anterrhinum* from Njoro, in British East Africa. The cornicles are marked, being slightly swollen on the apical half.

The alate female is described from spirit specimens, in which the colour had completely gone, and only apterae have been found at Glasgow.

In some of the African specimens the cornicles of the apterae are dusky, others are pale, as in the Scotch specimens. There are no structural differences, however, and in some of the Scotch apterae the cornicles were dark at the tips.

There is no doubt, I think, that both are Macchiate's species. Macchiate found it on *Anterrhinum majus* (cultivated), and on *A. oronthinum* at Reggio and Reggio-Campi.

60. **Macrosiphum betae** (Theobald).

Rhopalosiphum betae, Theobald.

Journal Bd. Agriculture, xix, No. 11 p. 918, 1913.

Apterous viviparous female.—Green of various shades, some pale, others of a deeper hue; apex of cornicles and the feet dusky. Eyes blackish red. Apices of antennae dusky. Cauda green.

Antennae with a small nail on the basal segment, the third segment longer than the fourth, the fourth longer than the fifth, the fifth with a single sub-apical sensorium, third to sixth segments imbricated. The cornicles slightly swelling on the apical half, and imbricated.

Cauda with three pairs of lateral chaetae.

Length.—1.5 mm.

Nymph.—Very similar to the apterous female. Wing buds green. The third segment of the antennae does not show imbrication. Cauda green and broad, with apparently only a single pair of chaetae.

Alate viviparous female.—Thorax black; abdomen green with black transverse bars and black lateral spots. Legs and antennae green, semi-transparent. Antennae with the third segment with eight to nine large and three to five small sensoria, fourth, fifth and sixth segments imbricated. Cornicles simple and with a few markings, but not true imbrication.

Cauda long, with three pairs of lateral chaetae and a sub-median pair near the apex.

Length.—2 mm.

Localities.—Herne Bay (4/7/11), winged and wingless females (mangolds); Wye (2 to 14/7/11), (beets), wingless females only; Faversham (4/7/11), and Dover (4/7/11), on mangolds; Bromley (2/7/11), on mangolds; also in various other parts of Thanet; Reading (10/7/12).

Food plants.—Mangolds, beet-root, sugar beet, and ornamental beets, and wild *Chenopodiaceae*.

Observations.—This green mangold aphis I originally described as a *Rhopalosiphum*, but as it has frontal tubercles it should come in this genus, in spite of the clavate cornicles. It occurs in isolated colonies, and causes the leaves to curl up.

The following species of Walker's are evidently of this genus:—

Aphis (Macrosiphum?) cyanoglossi, Walker.

Zoologist, vi, p. 2217.

Alate female pale greenish-yellow; crown greenish-brown; thorax above and below dark brown; a row of small black dots along back of abdomen; antennae black, much longer than body; cornicles pale yellow with black tips, one-fourth length of body. Legs long, pale yellow.

On *Cyanoglossum officinale*.

Aphis (Macrosiphum?) nigro-rufa, Walker.

Zoologist, vi, p. 2247.

Apterous female black, prothorax dull red; fore border, hind border and under-side pale red; abdomen dark red; antennae black, very much longer than body; rostrum yellow, black at apex; cornicles dull yellow with black tips, one-fourth length of body. Legs yellow, very long, apical half of femora and apex of tibiae and the tarsi black.

On *Anagallis arvensis*.

Aphis (Macrosiphum?) carduina, Walker.

Ann. Nat. Hist., Sec. Se. vi, 44, 89.

Apterous female small, oval, flat. Pale green, front bristly, a tubercle on each side; antennae yellow, much longer than body, tips of segments black, one and two angular, four much shorter than three, five as long as four; mouth pale yellow, its tip and eyes black; cauda short; cornicles pale green with black tips, one-fourth length of body. Legs long and pale yellow; knees, feet and tips of shanks black.

Alate female similar in colour, but darker about the chest; wings longer than body. Length, half line; wings, one and a half line.

Apterous female beginning of November; alate June to November.

NOTES ON AEOLOTHRIPIDAE, WITH DESCRIPTION OF A NEW SPECIES.

By

RICHARD S. BAGNALL, F.L.S., F.E.S.,

Hope Dept. of Zoology, University Museum, Oxford.

a. The Sub-families of the Family Aeolothripidae.
b. *Melanothrips ficalbii*, Buffa, an addition to the British Fauna.
c. *Aeolothrips tiliae*, n. sp., from Norway.
d. The genera *Franklinothrips* and *Mitothrips*.

(*a*) The Sub-families of the Family Aeolothripidae.

1. All antennal segments usually movable[1]; labial palpi with fewer segments than the maxillary palpi 2

Three, four, or five terminal antennal segments connate; maxillary palpi with three and labial with four segments.

Sub-family *Aeolothripinae,* mihi.

2. Palpi with an abnormal number of segments; namely, maxillary and labial respectively 8/5, 7/5 or 8/3 (or 4). Known genera Nearctic.

Sub-family *Orothripinae,* mihi.

Maxillary palpi with three segments and labial with two.

Sub-family *Melanothripinae*, mihi.

(*b*) Melanothrips ficalbii, Buffa, an addition to the British Fauna.

Melanothrips ficalbii, Buffa.

Buffa, Soc. Tosc. Sci. Nat. (Proc. verb.), July, 1907; and *l.c.* Memorie, 1907, xxiii, plates I and II.

Described from a few examples, including both sexes, found at Pisa, this species has not hitherto been recorded from elsewhere. It is sharply separated from the common *M. fuscus* (Suly.) by having the forewings banded (white with a dark band across middle, and another across tip), and the antennal joints two to four, yellowish, the fourth being tipped with grey-brown.

[1] In describing the genus *Stomatothrips*, Hood says of the antennae "segments 7-9 more or less compactly united."

On June 14th, whilst searching for *Rhipidothrips gratiosus,* Uzel, I secured several Aeolothripids from grass, etc., in a field on the Cherwell, near Oxford, which, with two exceptions, were referable to *Aeolothrips fasciatus* and *Melanothrips fuscus.* The exceptions were single female examples of *Rhipidothrips gratiosus,* Uzel., and *Melanothrips ficalbii,* Buffa. On the evening of the 17th June, Mr. J. Collins, of the Hope Department, secured a second example of *M. ficalbii* by sweeping long grass near Yarnton, where I have since secured another specimen.

I am especially pleased to be able to record this rare species as British.

(*c*) AEOLOTHRIPS TILIAE, SP. NOV., FROM NORWAY.

Aeolothrips tiliae, n. sp.

Female.—Length, 1.6 to 1.9 mm.

Colour blackish-brown (a crimson cast in certain lights, due to the deep hypodermal pigmentation), with joints three and four of the antennae, all tibiae apically, and all tarsi yellowish-white. Fore-wings white, with a brown band commencing at the basal fourth and extending to the apical fifth on the anterior margin, and almost to apex at posterior margin. Hind-wings with an obscure grey patch, extending from about one-half its length to the apical fifth.

Head slightly broader than long, sub-quadrate, cheeks behind eyes gently arcuate. Eyes rather coarsely facetted, occupying dorsally less than one-half the length of the head, but ventrally extending considerably towards base of the mouth-cone. Vertex raised in form of rounded hump; several minute setae on cheeks, dorsal part and vertex. Basal joints of antennae set below the vertex; approximate; third joint cylindrical; fourth about 0.8 the length of the third, slightly broadened distally.

Prothorax slightly transverse, about 0.7 as long as broad, and 0.9 the length of the head. Mesothorax narrower than prothorax and roundly widened to its juncture with the metathorax; metathorax narrowed to abdomen. Wings reaching to about the seventh abdominal segment; veins of fore-wing weak; cross-veins vestigial, so faint that they can only be discerned after close scrutiny under a high power. Setae along costa and longitudinal veins small, about 25 on costa, 17 on hind-vein, and 16-18 on fore-vein, the most distal eight being widely separated.

Cilia on lower margins only, moderately long and smoky-brown. Legs as in *tibialis,* set more or less regularly with short dark setae.

Abdomen elongate-ovate to eighth segment, ninth segment

nearly twice as long as the eighth, and narrowed evenly from base to apex of tenth (last) segment. Long bristles on ninth and tenth segments only; longer than the length of the tenth segment.

Type.—In Coll. Bagnall, University Museum, Oxford.

Habitat.—Not uncommon on lime (*Tilia*), Bygdø, near Christiania, June 27th, 1909 (R.S.B.).

I can only describe the female at present, from mounted specimens I made shortly after capture; but amongst my collections is a tube containing examples of both sexes, together with the earlier stages, which I have not at hand at present, but which I shall hope to describe later.

Separated (presumably) from all described species of *Aeolothrips s. str.*, by the vestigial nature of the cross-veins in the fore-wings. I was first inclined to refer the species to the recently diagnosed genus *Franklinothrips*, separated from *Aeolothrips* on account of the absence of these veins, but a close microscopical examination shows that the cross-veins in *tiliae* are present (or at least indicated!). I think it might be desirable to re-examine the Nearctic forms for any such indications.

A. tiliae most closely approaches *A. tibialis*, O. M. Reuter, and *A. versicolor*, Uzel., and may be distinguished from both by its larger size (1.6 to 1.9 mm., instead of 1.1 mm.), and by its relatively longer fourth antennal joint, which is only one-fifth (0.2) shorter than the third, instead of one-third (0.33) or two-fifths (0.4) shorter in the other species. It is further separated from *versicolor* by the colour of the body, and from *tibialis* by the coloration of the hind wing, which in the latter is clear white.

(*d*) The Genera Franklinothrips and Mitothrips.

In the Ent. Tijdskrift for 1912 the late Dr. Trybom described a new species of Aeolothripid from British East Africa, forming the type of the genus *Mitothrips*, and regarded it as congeneric with the recently described Nearctic species of *Aeolothrips*—*vespiformis, longiceps* and *nasturti*.

Before Trybom's paper was published, however, Back[1] published a note diagnosing the genus *Franklinothrips* with *vespiformis*, Crawford, as type, chiefly characterised by the absence of the cross-veins in the fore-wing,[2] so that, Trybom's and the Nearctic species

[1] Ent. News, Feb., 1912, xxiii.

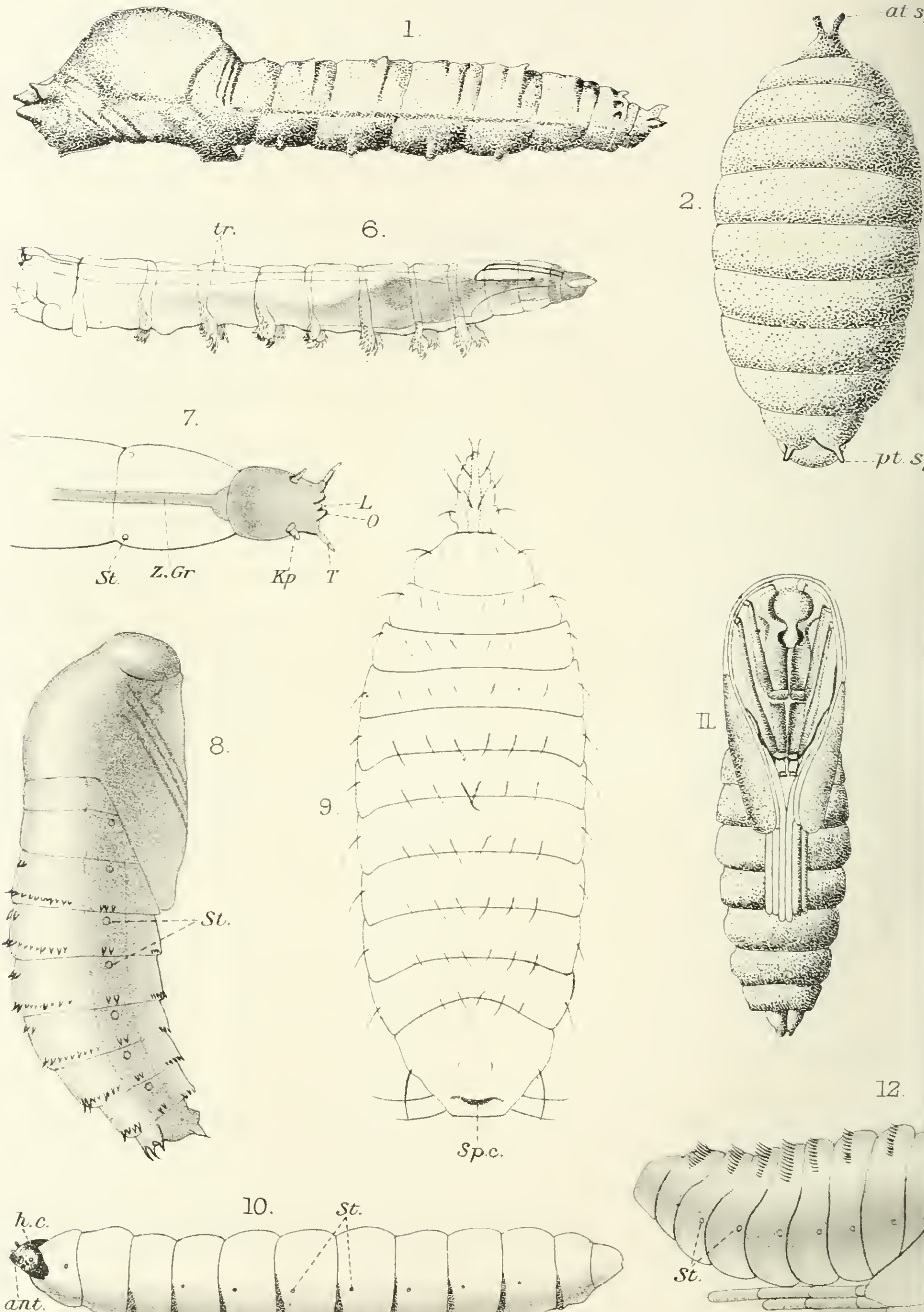
[2] In these present notes I have already suggested that the Nearctic species should be re-examined closely for traces of cross-veins.

being congeneric, the name *Mitothrips* sinks as a synonym of *Franklinothrips*, as I have already stated in a paper on the Aeolothripidiae presented before the International Entomological Congress held at Oxford last year.

But a study of Trybom's species, *M. megalops*, shows that it is a very different form to the Nearctic species, and apart from the absence of the cross-veins in the fore-wings, and the shape of the head which strongly converges anteriorly and has exceptionally large eyes, the structure of the antennae is such as to make it difficult to regard the species as congeneric with *Franklinothrips*. The antennae are extremely long and slender (from 6 to 6.5 times the length of the head!), the abnormal length lying solely in the strangely elongated third and fourth joints, and the *five* apical joints are distinctly connate. I therefore consider that *Mitothrips* cannot be regarded as synonymous with *Franklinothrips*, and must be regarded as a separate genus.

15-8ª

Journ. Econ. Biology, 1913. Vol. VIII, pt. 3.



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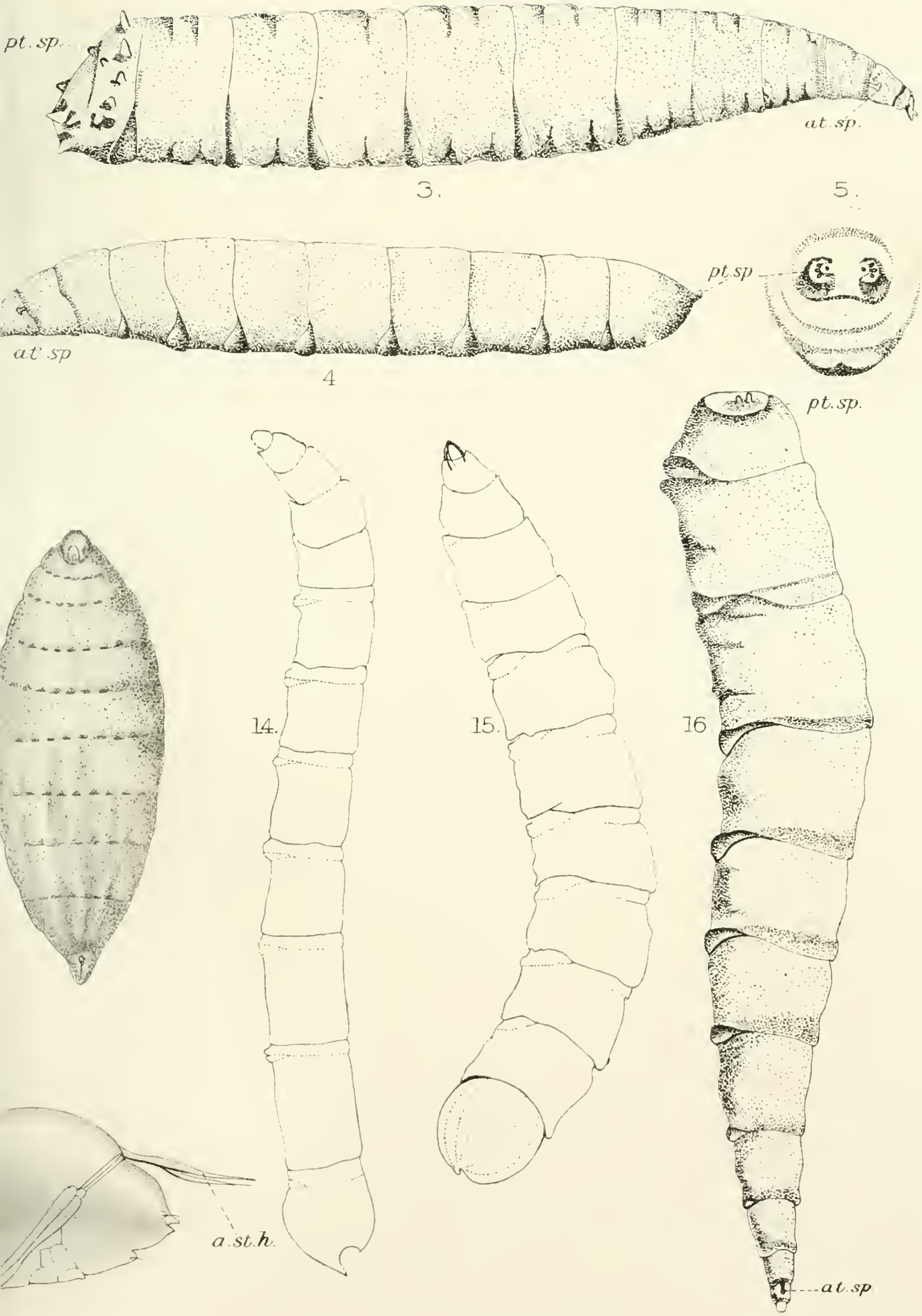
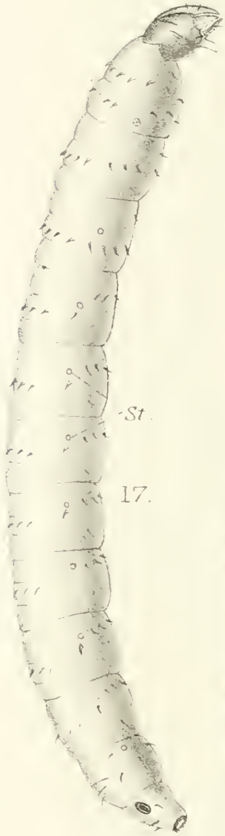


OF THE SOIL.

Huth sc. et imp

15-8 B.

Journ Econ. Biology, 1913, Vol. VIII, pt 3.



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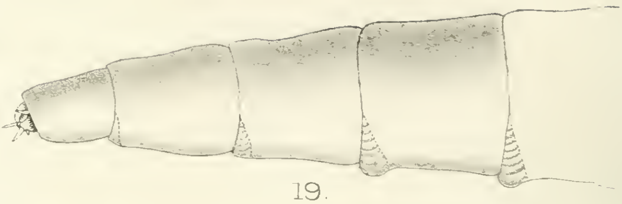

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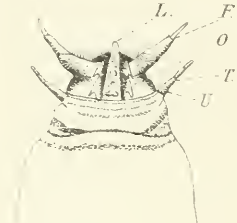

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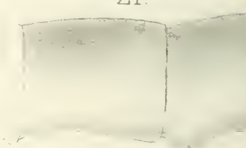

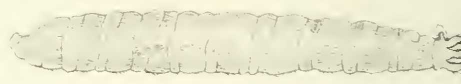

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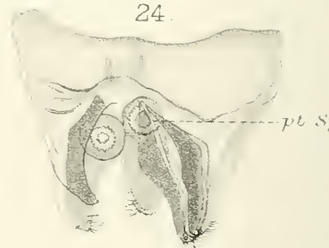

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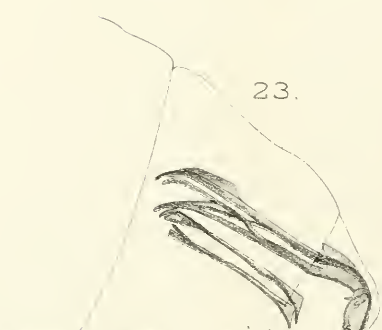

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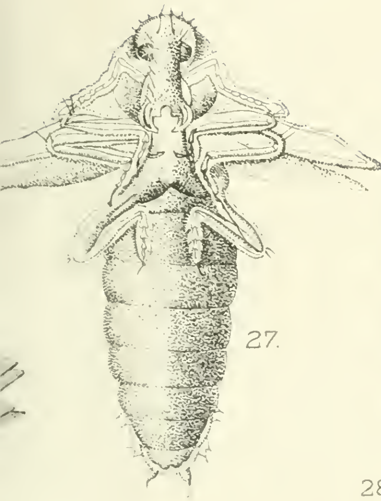

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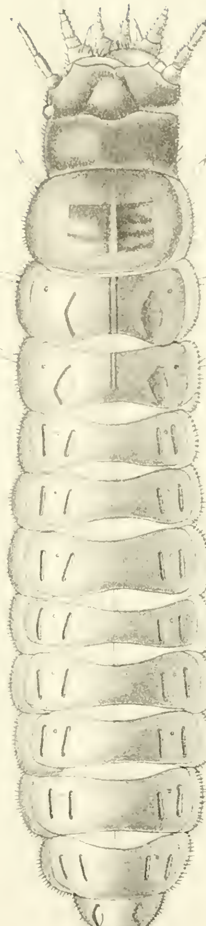

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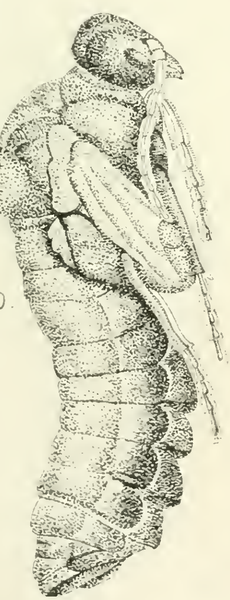

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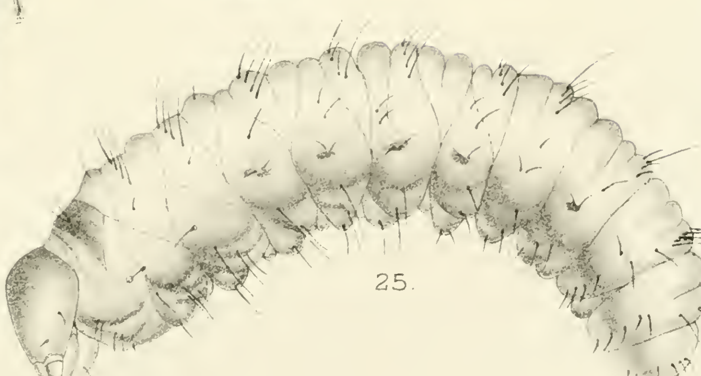

25.

OF THE SOIL.

Huth sc, et imp

GENERAL SURVEY OF THE INSECT FAUNA OF THE SOIL WITHIN A LIMITED AREA NEAR MANCHESTER; A CONSIDERATION OF THE RELATIONSHIPS BETWEEN SOIL INSECTS AND THE PHYSICAL CONDITIONS OF THEIR HABITAT.[1]

BY

ALFRED E. CAMERON, M.A., B.Sc. (Aberd.), M.Sc. (Manch.)

Board of Agriculture and Fisheries' Scholar, and Fullerton Scholar of the University of Aberdeen.

With Plates I and II and 3 Figures.

CONTENTS.

PART I.

GENERAL SURVEY OF THE INSECT FAUNA OF THE SOIL AT THE GROUNDS OF THE EXPERIMENTAL LABORATORY, FALLOWFIELD.

1.—Introduction.

"Soil is not a grave where death and quiet reign, but rather a birthplace where the cycles of life begin anew, to run their courses over and over again."

("The Soil," F. H. King, p. 75).

The term soil insect has rather a wide content, and for the purposes of this paper it is taken to mean any insect which at one time or another, in the course of its development from the egg to the fully

[1] Studies from the Department of Agricultural Zoology, Manchester University.

[Journ. Econ. Biol., September, 1913, vol. viii, No. 3.]

mature adult, spends some stage or stages of its life-history either on the surface of, or buried in the soil. Practically all the orders of the class Insecta furnish us with examples, beginning with the lowly Thysanura and Collembola, which are almost wholly terrestrial, and finishing with the most highly organised and complex orders of Diptera and Hymenoptera, where, with the exception of the species of apterous ants, the imago is never terrestrial. Of the holometabolic orders, that of the Coleoptera presents, especially in the families Carabidae and Staphylinidae, the great majority of cases where the complete life-history, egg, larva, pupa and imago, is passed in the soil, and the species of these two families of beetles may be regarded as characteristic types of soil insects.

No attempt, so far as I know, has hitherto been made to collect our information about terrestrial insects into a concise and accessible form, and it is the purpose of the present paper to bring together some details which may prove of general interest. Naturally, when one takes into consideration the size of the locality from which the material was obtained, only a very small fringe of the subject could be touched upon,—an exhaustive enquiry, in the circumstances, being altogether out of the question. But now that facilities have been provided for investigating a much larger district, new light may probably be shed, in a later paper, on some obscure problems.

From the economic standpoint, the relationship between soil insects and the physical conditions of the soil is far-reaching in its significance; but the subject is by no means a simple one, since complcations arise in that the crops which the fertile earth supports, must ever be a very important factor in our considerations. The agriculturist aims at maintaining the best tillage in order to get the greatest possible yield from his land. But it may be that he is often unwittingly adapting his soil to the favourable development of insect pests, and therefore harbouring enemies detrimental to his interests, especially those, I mean, which pass some stage of their life-history in the soil. But we may take it as an axiom that where other conditions are favourable, careful tillage will assist in the production of vigorous plants, which will suffer less from insect attacks than those that are weak and stunted in their growth. Hence the great value of proper manuring to carry the susceptible young plants quickly beyond the critical seedling stage, when, besides insect damage, there is often great liability to fungus rotting. The farmer, however thorough and practical in his methods, can never afford to neglect absolutely the insect factor and the study of economic entomology is now generally recognised as an important and

intimate branch of farm management as well as of orchard and forest cultivation. Thus a knowledge of the detailed life-history, and of the various affinities of an insect, often the major part of its destruction if it is a pest, cannot be appraised at too high a value. Curtis ('60, p. 514), whose work gave a great impetus to the study of economic entomology, says: "The first step towards vanquishing an enemy is to ascertain correctly its habits; the next to be so certain of his appearance as not to mistake one party for another; and a third and no less important object is to be well acquainted with our allies and friends."

2.—Description of Locality.

The grounds attached to the Economic Zoology Laboratory of the University, where the investigation was carried out, are situated within three miles from the centre of the city of Manchester, in the suburb of Fallowfield, and include a large field which is permanently kept in grass, mown at least once annually in the summer months. Skirting the field on the south side is a belt of large lime trees, *Tilia grandiflora*, Ehrh., while on the north side there are a few rather old alder trees, *Alnus glutinosa*, Gaertn., standing in a depression about two feet below the field, the level of which has been artificially raised. In this hollow there lie the decaying stumps and trunks of a few felled trees. On the west side a row of young poplars, *Populus nigra*, L., were planted about three years ago, whilst to the east, and fenced off from the athletic field, there was formerly a small orchard, of which some fruit trees and shrubs are reminiscent. Adjacent to this erstwhile orchard the experimental laboratory, with glass-houses attached, is situated, and the ground immediately in front of the laboratory is laid out in experimental beds, in some of which young goat willows, *Salix caprea*, L., osier willows, *Salix viminalis*, L., beeches, *Fagus sylvatica*, L., and birches, *Betula alba*, L., have been planted.

In the neighbourhood of Fallowfield the subsoil is composed of a tenacious clay, difficult to work, and imparting to the surface soil—by which is meant the upper six to twelve inches—its adhesive and flocculent nature. Thus, generally speaking, the soil hereabout is very retentive of water, the clay acting as a powerful check to leaching. The character of the soil within the grounds varies to some extent, due in great measure to cultivation and to applications of soil from other places, so that clayey loam, sandy loam and humus are all well represented, whilst vegetable refuse, in the shape of

decaying grass, leaves and bark lying on the ground, proves a veritable happy hunting ground for many soil insects.

Soils of fair to good quality which have been under grasses for many years are characterised by a rich velvety covering of perennial rye-grass and white clover, such as one generally finds in the best pastures; on the other hand, inferior soils have a heterogeneous mixture of permanent grasses, clovers and weeds. The pasture of the laboratory grounds falls under the latter category, including as it does perennial rye-grass, hard fescue, meadow foxtail, rough-stalked and smooth-stalked meadow grass, crested dogstail, with a small percentage of white clover, besides numerous weeds.

Insects are generally abundant amongst such grasses as these, other conditions being favourable; but as it is my intention to consider briefly the association of soil insects with the flora of the grounds later, I would here just quote a relevant passage from Curtis ('83, p. 498).

"No doubt, woods, forests, and grass land have been from the earliest ages the homes and habitations of the insect race. Grass especially is the natural covering of the soil, which has been increasing in depth and bulk from the creation, not only from the natural and annual decay of vegetable matter, but from the manure produced by herbaceous animals and the labours of the insect race. These again attract certain birds which feed upon them, as well as upon seeds, and supply, no doubt, an enormous amount of guano. Insects have therefore revelled unmolested in their native haunts from the creation, through the pastoral ages to the present period, and such localities will ever be the headquarters of this pigmy but formidable race, which were it not for the natural checks provided by Providence, would overrun the earth and eventually annihilate all vegetation. It is accordingly to be expected that grass lands would swarm with insect life, both above and below the surface; and being thus the nurseries for the deposition of the eggs and the nourishment of the larvae, it is naturally to be expected that a crop immediately succeeding fresh broken-up pasture land would fall a sacrifice to the inroads of insects, unless special care be taken to eradicate the enemy by paring and burning before the corn or other crops be sown.

It also becomes more difficult to obtain good yielding crops in a mixed tenure of corn and grass land, or in the neighbourhood of marches, pastures, and grass lands, as the insects bred there migrate to the adjoining arable lands, and often find food more agreeable to them than that which they have deserted, so that the click-beetles,

moths, and crane-flies depositing their eggs, the farmer soon finds his land infested by wire-worms, surface-grubs, and leather-jackets, to which his turnips, beet, and corn fall a sacrifice."

3.—Methods, Collecting.

In compiling material for a subject such as this, one has in the first place to resort almost entirely to the method of direct observation of the activities of the insects in the open, and this was the course principally followed here. This may be designated the field method in contra-distinction to the laboratory method, where conditions may be produced that never occur in nature. Yet the second of these methods may be of immense value in testing the truth of generalisations founded on the basis of the more practical field one; for in the laboratory we strive to attain the greatest possible accuracy in detail, and to eliminate as far as possible all possible sources of error. Both methods are valuable, and both are essential to a full knowledge of the relationships existing between the physical conditions of the soil and its insect fauna.

The investigation was carried on for a period extending over more than eighteen months, and during this time a great part of the area examined was dug up to a depth of about twelve to twenty-four inches, and the soil thoroughly sifted and searched for any insects which it might contain. Detection of insects was greatly facilitated by riddling the earth over a sheet of white canvas, when any specimens present were quickly observed. Only those larvae, pupae and imagines were considered which undergo development within the confines of the soil, and are closely associated with it either super- or subterraneously. Every insect thus obtained was recorded, and a note was made of the general character of the soil, and of the depth of the insect in the soil. The results were then incorporated in the table which follows. Specimens of larvae and pupae were preserved either in 70 per cent. alcohol or 2 per cent. formalin, but were first killed by being placed in water, the temperature of which has been raised to the boiling point for about thirty seconds. It was experienced that by this treatment the larvae of Diptera and Coleoptera, as well as pupae, retained their natural colour better than those placed directly in spirit, the only objection being that the boiling water caused them to become somewhat unnaturally extended. Spirit specimens of Lepidopterous larvae soon become discoloured in alcohol, formalin being a better preservative. The small glass tubes in which the specimens were preserved were labelled with the name and the date on which the contents were

collected, and, after being classified and arranged according to their orders, they were stored for future reference.

In many cases larvae and pupae could not be specifically identified offhand. Accordingly, some were put up in spirit, while others were transferred to breeding jars or cages as the case might be, and on the emergence of the adult, the identification of the larva or pupa, or of both, was established. All adults thus reared were mounted, named, dated, added to the general collection, and kept in cabinets.

Careful and painstaking search must always be made; for certain larvae, such as those of some Stratiomyiidae, *e.g.*, *Microchrysa polita* (fig. 9), and many adult Coleoptera, such as some weevils, assimilate so much in appearance to their earthen background that they may be easily overlooked. Larvae of predaceous Carabidae and Staphylinidae are usually found, when present, with very little effort, for they betray themselves as soon as they become exposed to daylight, by straightway attempting to find shelter. Two species of Telephoridae, *T. fuscus* and *T. darwinianus* (figs. 28, 29), occurred in abundance. When disturbed the larvae feign death, remaining inactive for quite a considerable time, coiled up on one side, with the abdomen curled forward so that the posterior segment approximates to the head. Sometimes they roll themselves into a compact flat spiral, and their brown earthy colour renders it difficult to any but the experienced to find them.

All larvae of a fleshy colour, such as those of the Dipterous families, Mycetophilidae, Bibionidae, Leptidae, Anthomyiidae, Muscidae, and amongst Coleoptera, those of Rhyncophora, show up very easily against the dark soil, but the larvae of some Tipulidae only betray their presence if they should make a movement when disturbed.

Adult weevils of the genera *Otiorhynchus* and *Barynotus* may very easily escape observation; for as soon as they are disturbed they tuck their legs well under the thorax and abdomen, feigning death, and from their dark colour they may be readily mistaken for inorganic particles. Many specimens of *Otiorhynchus* and *Barynotus* in the orchard were only discovered on examination of samples of soil in a glass tray in the laboratory. But altogether they were not very numerous in the grounds.

Larvae of Noctuidae, or surface-caterpillars, which generally abound at the roots of grasses in permanent pasture-land, were, on the whole, well represented, as will be seen on referring to the list of insects tabulated, and there was not much difficulty in finding

them. The same may be said of the pupae of Lepidoptera generally and of Coleoptera, but the puparia of the cyclorrhaphous Diptera, on account of their small, dark, seed-like appearance, did not so easily reveal themselves to the eye as the naked pupae of the orthorrhaphous families of this order.

From the preceding remarks it will be readily noted that the research is of an exacting nature, and much spade-work, both literally and metaphorically, had to be accomplished in its execution. But the interest is always maintained by reason of the delightful uncertainty attached to collecting, and in this respect alone I consider myself to have been amply repaid. For example, in the small area at Fallowfield whole masses of the larvae of *Boletophila cinerea* (figs. 10, 11), of which no specimens had hitherto been received in the collection of the Natural History Museum, South Kensington, were found in the soil, and several examples sent to the Entomological Department there; whilst two Ichneumonid parasites, *Homocidus dimidiatus* and *H. tarsatorius*, were definitely established as being parasitic on a Syrphid, *Platychirus albimanus*, which pupates in the soil. Nothing was previously known of their economy, and a short account has been published elsewhere by the author ('13).

4.—Flora of the Grounds, and Food Habits of Soil Insects.

When we realise that the soil is an important ecological factor in determining the floristic composition of a district, and that many insects are dependent for food on one or more definite species of plants, we at once have at least a part explanation of why some insects are found to occur in one region and not in another. As Bevis and Jeffrey ('11, p. 84) say: "Climate determines the broad features of the vegetation, but the minor differences in the flora are due to the character of the soil and the way it behaves towards the external sources of heat and moisture." The reason for the great variations in the flora of any one district lies in the fact that different soils react differently to climatic conditions, the rays of the sun imparting more or less heat according as a soil is dark- or light-coloured, whilst its capacity for water is very much an attribute of its texture and structure.

As previously stated, the subsoil of the grounds is composed of clay, damp and heavy, characteristic of South Lancashire generally, and the association of grasses and weeds found thereon is typical of a soil of this kind. Periodically the field is manured, and, whilst the constitution of a flora varies with the chemical and physical

nature of the soil, it must also be remembered that the application of manures is not without its influence on the vegetation. Tansley '11, p. 84) says: "In general it may be said that heavy long-continued manuring reduces the number of species occurring in the grass-land, while special kinds of 'one-sided' manuring sometimes lead to the introduction of new species." The same author also calls attention to the experiments carried out for a period of over fifty years at the Rothamstead Experimental Station, in order to bear out this statement.

The following is a list of the commoner grasses and weeds which grow abundantly in the area examined at Fallowfield, and in the table which follows, the host-plants, together with the soil insects which were found to subsist on them, are given.

Lolium perenne.	Bellis perennis.
Cynosurus cristatus.	Achillea millefolium.
Anthoxanthum odoratum.	Chrysanthemum leucanthemum.
Dactylis glomerata.	Senecio jacobaea.
Alopecurus pratensis.	Senecio vulgaris.
Festuca duriuscala.	Leontodon hispidus.
Festuca elatior.	Taraxacum dens-leonis.
Poa annua.	Crepis virens.
Poa pratensis.	Hieracium pilosella.
Aira flexuosa.	Lapsana communis.
Phleum pratense.	Lysimachia vulgaris.
Luzula campestris.	Primula veris.
Ranunculus acris.	Rhinanthus crista-galli.
Ranunculus repens.	Epilobium montanum.
Cardamine pratensis.	Chenopodium ficifolia.
Polygala vulgaris.	Chenopodium bonus-henricus.
Cerastium triviale.	Claytonia alsinoides.
Stellaria media.	Prunella vulgaris.
Capsella bursa-pastoris.	Stachys sylvatica.
Trifolium pratense.	Plantago lanceolata.
Trifolium dubium.	Plantago major.
Lotus major.	Rumex crispus.
Lathyrus pratensis.	Polygonum aviculare.
Potentilla tormentilla.	Polygonum persicaria.

Host Plant.	Soil Insect Larvae.
Dactylis glomerata ...	*Hepialus humuli*, *Leucania comma*.
Festuca duriuscula, Festuca elatior . .	*Dolerus gonager*, *Dolerus haematodis*, *Dolerus picipes*.

Host Plant.	Soil Insect Larvae.
Poa annua Poa pratensis ...	Larvae of Cecidomyiidae, Mycetophilidae, Tipulidae, Bibionidae; larvae of Elateridae; larvae of *Otiorynchus picipes*, *O. sulcatus*, *Barynotus obscuras*; various species of Noctuiidae of the genera *Triphaena*, *Xylophasia*, *Hadena*, *Hydroecia*; also of the Muscid type of Diptera, *Onesia sepulcralis*, *Pollenia rudis*, *Hyetodesia incana*, *H. populi*.
Aira flexuosa ...	*Luperina testacea*, *Apamea gemina*.
Phleum pratense ...	*Apamea gemina*.
Luzula campestris ..	*Leucania impura*, *Apamea gemina*.
Cerastium triviale Stellaria media ...	*Triphaena pronuba*, *T. orbona*, *Agrotis exclamationis*.
Trifolium pratense Trifolium dubium ..	*Agrotis corticea*.
Senecio jacobaea ...	*Rhyphus fenestralis* (one specimen at root).
Senecio vulgaris ...	*Spilographa Zoë*.
Taraxacum Dens-leonis	*Agrotis obscura*, *A. exclamationis*, *Triphaena pronuba*.
Plantago lanceolata Plantago major	*Agrotis segetum*, *A. exclamationis*, *Triphaena pronuba*, *T. orbona*.
Rumex crispus .	Various species of Noctuiidae, including species of *Triphaena*, *Xylophasia*, *Mamestra*; *Pegomyia bicolor*.

By referring to the table it will be seen that those insects which are reputedly destructive to pasture land are well represented. *Dilophus febrilis* (figs. 1, 17), the Fever Fly, probably the most injurious of the Bibionids, was frequently found in the larval stage feeding indiscriminately on the roots of grasses. This insect is double-brooded, and after hibernating the larvae pupate in early spring, the adults emerging in May. The larvae of this early summer brood of flies develop much more quickly, and the adults appear in August and September. Of other Bibionids, *B. hortulanus*, *B. laniger*, and *B. johannis* were also present in number. The original home of this family is in all probability manures of various kinds, and both Curtis ('83), and Theobald ('92, p. 162), who have bred different species in quantity from cow and horse dung, are of this opinion. Hence there is often serious danger of introducing insect pests to crops along with manure. Although only migrants, many of them show a wonderful adaptability in the matter of diet, and, once established, they are not easily eradicated. Grass roots apparently form a nutritious food, to which they take

naturally, and on which they thrive. Mention need only be made of the Cabbage Root Maggot, *Anthomyia radicum*, and of the Onion Maggot, *Anthomyia ceparum*, to bear out the truth of the statement that manure-feeding insects may become serious pests of healthy, cultivated plants.

Several species of Cecidomyiids and Mycetophilids also exact toll from grass roots, particularly those of meadow grass, but the latter usually derive their nourishment from various species of fungi, hence the name of the family. The larvae of *Boletophila cinerea* (figs. 10, 11) were found only where vegetable matter was undergoing decay, but the larvae of *Sciara carbonaria* appeared to live freely in the soil amongst the network of roots which alone could have supplied them with food.

In all, four species of Tipulidae, *Dicranomyia chorea, Trichocera hiemalis, Pachyrrhina imperialis, Tipula oleracea*, were found to occur prevalently. All four pass their larval and pupal stages in the environment of the soil, mostly beneath the surface; and whilst three of them may become injurious where present in numbers, *T. hiemalis*, the Winter Gnat, is practically harmless. But cases are known where it has been bred from turnips. Theobald ('03, p. 95), referring to *P. maculosa*, the Spotted Crane Fly, an allied species of *P. imperialis*, says: "It is mainly in undisturbed ground that these insects propagate, especially where there is moisture, as in damp meadows, marshes, and amongst the vegetation along dykes and ditches. The smaller larvae of *P. maculosa* occur most abundantly on light soils, but not by any means entirely, for I have seen them in swarms during the past year on clay land. They occur in hilly districts just as abundantly as in low-lying marshy land, in light and heavy soil; in fact, they have as wide a distribution as the common Crane Fly." So far as my own observations are concerned Leather-jackets are more prevalent in soils of a clayey than of a sandy consistency. The same author further states that grass land and root-crops perhaps suffer more than anything else from the ravages of what is popularly also known as the "Grub," and in grass land and clover lay they find congenial surroundings amongst the tangled growth of roots, whilst turnip and potato fields are not exempt from their depredations. Neither is clean garden soil immune from these pests, which are partial to all manner of vegetables. Leather-jackets do not travel about to any great extent in the soil, and where food is plentiful, as in grass land, they individually confine their activities within a comparatively small radius, but this limitation of movement is more than balanced by the effect of

their voracious appetites, and by their great numbers, so that pastures where they are present soon begin to appear bare, as if scorched by the sun's heat. The same may be said with equal truth of wire-worms, of the species of which listed as occurring in the grounds, *Cryptohypnus riparius* and *Agriotes lineatus* were most frequently met with.

Where the soil was decidedly humous and damp, covered by loose grass and decaying leaves, several larvae and pupae of *Leptis scolopacea* (figs. 8, 20, 21) were found in the beginning of the present year, and the adults emerged during April in the laboratory breeding cages. One or more other species of Leptids have not yet been identified, efforts at rearing having so far proved unsuccessful. As the members of this family are notoriously predaceous in the larval as well as in the adult stage, they in all probability prove of some utility in the economy of the soil fauna. The few examples of the larvae of *Thereva nobilitata* (fig. 7), also predaceous, occurred chiefly in loose sandy soil, a fact which Collinge ('09, p. 15) also notes. This author finds too that in wet sticky soil they generally take advantage of worm burrows in travelling about, and he has observed one feeding on a small earthworm. One specimen which I disturbed in its earthen lair was making a meal of a muscid larva. Beling ('75, pp. 45-46), in treating of the life-history of this insect, has the following passage, in which he sums up the habits of the larva. From this it would appear that it does not confine itself absolutely to the soil. "Die Larven, deren Weiterführung zu Puppe und Imago mir nur in den Fällen gelang, wenn sie bereits vollstandig erwachsen waren, fand ich seit dem Jahre 1871 öfter, aber immer vereinzelt, an sehr verschiedenen Orten, insbesondere in älteren Fichten—und Kiefern—Bestanden unter der Nadeldecke, auch wohl in und unter dem Moosüberzuge des Bodens, seltener in Laubholzbeständen unter Laub und Geniste, so wie in altem kuhdung auf Viehruhen, sodann in alten, in Vermoderung begriffenen Laubholz—namentlich Erlen-Stöcken im Walde, einige Male auch in der Erde an Feldhecken. Sie scheinen vorzugsweise von in Verwesung befindlichen vegetabilischen Substangen zu leben, vergreifen sich aber auch an Larven andever Insecten und ihrer eigenen Art."

One species of Stratiomyiid, *Michrochoysa polita*, abundant where it occurred, was found to be feeding in the larval stage upon decaying vegetable matter, in a very damp situation. Of the soil Muscids and Anthomyiids, the former were most generally met with, breeding amongst decaying organic matter on which the larvae subsisted, but a few species of the latter family, including *Hyetodesia incana* (fig. 16), *H. populi*, and *Anthomyia radicum* (fig. 3), were

also not infrequently present at the roots of grasses from which they derived sustenance. On an average, during the autumn there would have been about a dozen Anthomyiid larvae per square yard of soil. Certain other species of Diptera I have as yet been unsuccessful in rearing, but nevertheless, I have figured some of them as a matter of interest (figs. 3, 4, 13, 14, 15, 22, 23), and I yet hope to be able to acquire further information regarding the details of their life-histories and habits. Mention may be made of one other species of Dipterous larva which occurred but seldom, and generally in moist earth rich in decaying vegetation. This is *Dolichopus aeneus* (fig. 6), the pupa (fig. 12) of which is characterised by its peculiar abdominal rotatory movement when disturbed. Brauer ('83, p. 44) says: "Die Larve lebt in feuchter modererde in hohlen Weisspappeln," and its diet is probably a vegetarian one.

As the various species of surface caterpillars, with their host plants, have been treated of rather fully in the table, there will be no need to deal with them further here.

Amongst the Coleoptera the larvae of *Otiorhynchus picipes, O. sulcatus* (fig. 25), *Exomias aranciformis* (fig. 26), and *Barynotus obscurus* subsisted on the roots of grasses chiefly, those of *Aphodius contaminatus* and *Geotrupes stercorarius* on the roots of garden plants. As regards the habits of the two species of Telephorids, *T. fuscus* (figs. 28, 29) and *T. darwinianus*, no definite information was ascertainable, but probably the larvae enjoy a mixed diet. At least in the breeding cages they devoured both dipterous larvae and grass roots, proving themselves at once carnivorous and vegetarian. One adult of *Rhizophagus parallelocollis* was found feeding on the dead body of an earthworm covered with Lipurids which were apparently also actively engaged in its demolition.

The subject of the habits of soil insects would be incomplete without a short summary of the present state of our knowledge regarding the food of the predaceous families of the Coleoptera. So far as I am aware, no exhaustive work has been done in the way of establishing clearly and definitely the exact nature of the diet of the various species of the Carabidae and Staphylinidae. Conclusive proof can only be got by dissecting out the contents of the alimentary canal and examining them microscopically. Where the insect ingests its food in the liquid form a settlement of the question is not so easy. Only by investigation along this line can we arrive at a definite conclusion as to which species are beneficial and which injurious. To a limited extent researches have been carried out in America, and the results incorporated in two short papers by F. M.

Webster ('03) and S. A. Forbes ('03), for certain species of Carabidae and Coccinellidae; and whereas it was generally accepted that all the members of these active families preyed upon insects injurious to the agriculturist, and thereby were worthy of his protection, these authors have caused us to doubt the strict usefulness of many species formerly considered wholly predaceous and carnivorous; for at least some are now known to be vegetarian also in their diet. It is probable that others will be brought before the tribunal, and the deception which exists will, once and for all, be removed.

Webster ('03, p. 162) says: "In the Coleoptera it would be difficult to point out a single species, the food habits of which we fully understand, when both the larvae and imago state are taken into consideration." Certain species are known by entomologists to feed upon certain substances, but this isn't an absolute criterion that nothing else enters into their natural diet. An illustration of the change of food habit in the larval and adult stages has been cited by Curtis ('83, p. 388), who found that the larva of the Burying Beetle, *Silpha opaca,* also known as the Carrion Beetle, fed upon the fresh expanding leaves of the mangel-wurzel in addition to the putrefying flesh of dead animals, and in the years 1844-47 he states that great loss was incurred in certain districts of Ireland by the larvae attacking crops of mangel-wurzel, beet and turnips. Of the Carabidae, which are grain destroyers in Europe, there are, besides *Zabrus gibbus* in both stages, various species of *Pterostichus, Amara, Omophron,* and *Calathus latus,* Westw. Each causes injury by eating off the young shoots or destroying the seed. *Omaseus madidus* and *Harpalus aeneus* have been proved up to the hilt to cause serious damage in some districts to the strawberry plant, and the former also does damage by eating through the beet plant immediately above the surface of the ground.

Forbes ('03, p. 173) supplies some very interesting information as a result of his examination of the contents of the alimentary canals of twenty-eight specimens of Carabids, representing seventeen species. To quote his own words: "Twenty-one specimens, belonging to fifteen species, had eaten animal food, and twenty specimens, belonging to eleven species, had eaten vegetation of some sort. I estimated as carefully as possible the relative amounts of these two kinds of food in the alimentary canal of each insect, and from these data concluded that about half the food of these twenty-eight specimens consisted of vegetation, and that one-third of it consisted certainly of insects, the remainder being made up of doubtful animal matter. About one-third of the vegetable food has

been derived from cryptogamic plants, and another third from the different structures of grasses, Compositae and other miscellaneous vegetation making up the remainder. Considering the fact, however, that the commonest species were found feeding upon vegetation far the most generally, it is likely that, taking the Carabidae as a group, not more than one-third or one-fourth of their average food consists of animal matter." Before we can form conclusions of any value large numbers of insects must be investigated, and it seems to me that this last statement of Forbes' is worthy of verification.

The Carabidae are essentially terrestrial in all stages of their life-history, and since certain kinds and conditions of soils suit certain types of vegetation more than others, it is probable that by structural changes less chance of serious damage may be incurred from the attacks of these convicted crop-destroyers; for the physical conditions of the soil have no less a significant bearing upon the welfare of soil insects than upon that of plants, as we shall endeavour to show.

As regards the Apterygota, I have adopted the nomenclature of Collinge and Shoebotham ('10), who give a comprehensive list of the literature bearing on this group in their work, "The Apterygota of Hertfordshire." That this group is worthy of the consideration of the economic entomologist has been fully demonstrated by the recent researches of Professor Carpenter ('09), W. E. Collinge ('10), and F. V. Theobald ('10), and the work of these scientists must be consulted for a full account of the injuries caused by these insects, which, although of insignificant size, yet make up for their minuteness by their extreme prevalence of numbers under certain circumstances. Curtis ('83, p. 433) remarks on the damage caused by *Sminthurus* and *Podura,* and, contrary to the experience of later observers, he says that these "ground fleas" will not remain on damp ground, and therefore advocates the sprinkling of salt or a thin layer of sea-weed as a means of expelling them. Theobald ('10, Rep. Econ. Zool., p. 126), on the other hand, says: "Other observers have noticed that the springtails object to dryness. This is certainly my own experience, and in all cases of bad attack it has been in damp seasons, and where plants are in damp positions, or grown under damp conditions, that damage is done. Any drying agents seem at once to drive them away." Referring to an attack on currants which he had in his own garden, and which he could therefore keep under constant observation, the same author further states: "The yellow springtail worked most in shaded spots, and

that once the sun dried up the foliage and soil a check came in the damage. This was equally noticeable in sweet peas being damaged by Sminthuri." My own observations induce me to corroborate Theobald's statement that drought is detrimental to springtails. At least the various species which I have collected, and here tabulated, were all found in situations where the conditions were decidedly humid and sheltered from the direct rays of the sun. As soon as the soil became dry no trace of them was to be found, but they soon reappeared after a shower of rain. In the case of two species of *Entomobrya, E. nivalis,* and *E. albocincta,* soil which contained a large proportion of decaying vegetable matter apparently offered an ideal breeding place, immature and adult forms occurring in numbers. Especially was this noticeable where some alder trees had been attacked by a Myxomycete fungus at the base of the trunk near the ground. The removal of the soil revealed large swarms of both of these species, as well as of *Onychiurus fimetaria* and *O. ambulans.* I suspect that they were feeding on the organic debris resulting from the activities of the Myxomycete. *Campodea staphylinus,* a widely distributed species of *Thysanura,* which one frequently finds in turning over moist garden soil quickly vanishes in the small crevices on being disturbed. Most generally it occurs where the soil is not too much compacted, so that its agile movements are not hampered. Pasture land, where the delicate fibrous grass roots weave the soil particles together, does not offer sufficient scope for its burrowing propensities, and so it is more often found where the soil is of a loose, open texture, such as in gardens. Wherever there are decaying leaves or grass, or, in fact, anything left lying on the surface of the ground and likely to conserve moisture, there one is almost sure to find some species or other of the Apterygota. As a rule they do not penetrate deeply into the soil, generally being found in the first three inches. In many cases where members of this order have been reported as doing damage to root crops, I doubt very much whether they are the direct agents of injury. The chances are that they are merely what we term "followers of decay," accentuating the evil that has been already caused by other pests.

5.—Table of Soil Insects.

In the table below, 'surface' denotes that the insect was found lying on the top or buried in the first three inches of the soil, and one will readily observe, on casting one's eyes over the fourth

column, that the majority of those dealt with do not descend very deep down. If they do so the concomitant circumstances are generally exceptional, such as a decided fall of temperature, to instance but one. On the other hand, it is in the natural course of events that a soil larva burrows well into the subsoil when about to pupate. Wireworms, on reaching maturity, descend to a considerable depth in the earth and there form a cell composed of the surrounding particles of soil, and the same holds

Fig. A.—Photograph of *Forficula*.

good of most surface-caterpillars. The 'approximate depth' then indicates the average position of the insect in the soil when untrammelled by any extraordinary conditions. In the Carabidae and Staphylinidae, the species of which were rather numerous in the grounds, the larva and pupa occur deeper down than the adults, which generally frequent the surface. Many species of these two families hibernate as adults, such as, for example, *Carabus violaceus*, *Patrobus assimilis*, *Anchomenus angusticollis*, *Tachy-*

porus chrysomelinus, but they do not usually descend further than about three or four inches, and, indeed, mostly pass the winter in a comatose-like state about an inch or two beneath the surface.

The "egg-stage" has not been included in the table. In the great number of cases where an insect passes one or other of its developmental stages in or on the soil, the eggs are deposited on

Fig. B.—Cocoon of *Triphaena pronuba*.

the ground, as, for example, those of ground-beetles and Elateridae; at the roots of plants, those of many Noctuidae and various species of Diptera, *e.g.*, Crane-flies; on grasses or other plants, those of various species of *Dolerus* and leaf-mining Diptera, *e.g.*, *Pegomyia hyoscyami* and *Phytomyza affinis* (fig. 2, puparium). But no general rule can be formulated.

Insect.	Stage in Life-history.	General Character of Soil.	Approximate Depth of Insect in Soil.
Thysanura.			
Campodea staphylinus, Westw.	all stages	Loose garden loam	surface
Collembola.			
Achorutes viaticus, Tullb.	,,	Garden soil	,,
Achorutes purpurescens, Lubb.	,,	Decaying wood and humus	,,
Onychiurus fimetarius, Linn.	,,	Moist decaying leaves and humus	,,

Insect.	Stage in Life-history.	General Character of Soil.	Approximate Depth of Insect in Soil.
Onychiurus ambulans, Linn.	all stages	Moist decaying leaves and humus	surface
Isotoma grisea, Lubb.	,,	Loose loam	,,
Tomocerus minor, Lubb.	,,	Decaying leaves	,,
Entomobrya nivalis, Linn.	,,	Loose soil covered by mown grass, and amongst humus soil at roots of trees	,,
Entomobrya albocincta, Templ.	,,	Same as in previous species	,,
Lepidocyrtus albus, Pack.	,,	Decaying leaves and loose loam	,,
Dermaptera.			
Forficula auricularia	,,	Sandy loam, loose, and under grass	,,
Neuroptera.			
Hemerobius nervosus	cocoon	Light, sandy	,,
Chrysopa vulgaris, L.	,,	,,	,,
Lepidoptera.			
Phalera bucephala, L.	pupa	Loam	,,
Leucania comma, L.	larva, pupa	Clay loam	surface to 12″
Leucania impura, Hb.	,,	,,	,,
Hydroecia nictitans, Bork.	,,	Sandy loam	6″
Hydroecia micacea, Esp.	,,	,,	6″
Xylophasia lithoxylea, Fb.	,,	Clayey	9″
Xylophasia monoglypha, Hufn.	,,	,,	,,
Luperina testacea, Hb.	,,	Variable, under stones	surface
Mamestra brassicae, L.	,,	Loam	,,
Apamea gemina, Hb.	,,	Sandy	,,
Agrotis segetum, Schiff.	,,	Loam	surface to 9″
Agrotis exclamationis, L.	,,	,,	,,
Agrotis corticea, Hb.	,,	,,	,,
Agrotis obscura, Hb.	,,	Light, loamy	,,
Triphaena orbona, Fb.	,,	Loamy	surface to 6″
Triphaena pronuba, L.	,,	,,	,,
Taeniocampa incerta, Hufn.	pupa	Loose, sandy	surface
Taeniocampa populeti, Fb.	,,	,,	,,
Hadena oleracea, L.	larva, pupa	Clay loam	,,
Hepialus humuli, L.	,,	Clayey	surface to 12″

Insect.	Stage in Life-history.	General Character of Soil.	Approximate Depth of Insect in Soil.
Coleoptera.			
Carabus violaceus, L.	larva, pupa, imago	Loose, under grass	surface to 6″
Notiophilus aquaticus, L.	,,	Light, sandy loam	surface
Leistus rufescens, F.	,,	Loose, loamy	,,
Nebria brevicoillis, F.	,,	Loose, sandy	,,
Nebria gyllenhali,	,,	,,	,,
Loricera pilicornis, F.	,,	Loose	,,
Clivina fossor, L.	,,	Sandy loam	,,
Bradycellus verbasci, Duft.	,,	Loose	surface to 6″
Pterostichus madidus, F.	,,	Loose soil, under grass, and vegetable refuse	,,
Pterostichus vulgaris, L.	,,	Loose, and sod	,,
Pterostichus albipes	,,	Loose, sandy, and sod	,,
Pterostichus minor, Gyll.	,,	,,	,,
Pterostichus strenuus, Pz.	,,	,,	,,
Pterostichus diligens, Stm.	,,	,,	,,
Pterostichus vernalis, Pz.	,,	,,	,,
Amara similata, Gyll.	,,	,,	,,
Calathus melanocephalus, L.	,,	,,	,,
Anchomenus angusticollis, F.	,,	,,	,,
Anchomenus dorsalis, Müll.	,,	,,	,,
Anchomenus albipes, F.	,,	,,	,,
Anchomenus parumpunctatus, F.	,,	,,	,,
Bembidium littorale, Ol.	,,	Compact, sandy	surface to 3″
Trichus minutus, F.	,,	Loose and decaying refuse	surface
Patrobus excavatus, Pk.	,,	Sandy loam, and sod	surface to 6″
Patrobus assimilis, Chaud.	,,	,,	,,
Dromius quadrimaculatus, L.	,,	Loose, and under pieces of bark	surface
Sphaeridium bipustulatum, F.	,,	Vegetable refuse and humus	6″ to 12″
Cercyon littoralis, Gyll.	,,	Vegetable refuse and humus	,,
Aleochara fuscipes. F.	,,	Vegetable refuse	surface
Homalota analis, Gr.	,,	Sandy loam and detritus	,,
Homalota xanthoptera, Steph	,,	Vegetable refuse	,,

Insect.	Stage in Life-history.	General Character of Soil.	Approximate Depth of Insect in Soil.
Homalota trinotata, Kr.	larva, pupa, imago	Manure	surface
Tachyporus obtusus, L.	,,	Vegetable refuse	,,
Tachyporus chrysomelinus, L.	,,	Sandy loam, and sod	,,
Tachyporus pusillus, Gr.	,,	Vegetable refuse	,,
Tachinus flavipes	,,	,,	,,
Tachinus rufipes, De G.	,,	Vegetable & animal detritus	,,
Quedius fulgidus, F.	,,	Sandy loam and vegetable refuse	,,
Quedius cinctus, Pk.	,,	Sandy loam and vegetable refuse	,,
Quedius fuliginosus, Gr.	,,	Sandy loam, sod	,,
Quedius tristis, Gr.	,,	Vegetable refuse	,,
Quedius picipes, Man.	,,	,,	,,
Quedius umbrinus, Er.	,,	Under stones, among grass	,,
Ocypus oleus, Müll.	,,	Loose, sandy loam, and sod	,,
Philonthus aeneus, Ross	,,	Loose, sandy loam, and sod	,,
Philonthus laminatus, Creutz	,,	Vegetable refuse and sandy loam	,,
Philonthus decorus, Gr.	,,	Vegetable refuse	,,
Philonthus politus, F.	,,	Animal refuse	,,
Philonthus varius, Gyll.	,,	,,	,,
Philonthus debilis, Gr.	,,	Vegetable refuse	,,
Xantholinus fulgidus, F.	,,	Vegetable refuse and sandy loam	,,
Xantholinus punctulatus, Pk.	,,	Vegetable refuse	,,
Xantholinus linearis, Ol.	,,	Vegetable refuse and sandy loam	,,
Platystethus arenarius, Fourc.	,,	Vegetable refuse	,,
Oxytelus rugosus, F.	,,	Loam and sod	,,
Oxytelus nitidulus, Gr.	,,	Vegetable refuse	,,
Oxytelus tetracarinatus, Block.	,,	,,	,,
Rhigophagus parallelocollis, Gyll.	,,	Sandy loam	6″
Aphodius contaminatus, Hbst	,,	Loose, sandy loam	,,
Geotrupes stercorarius, L.	,,	Sandy loam (garden)	6″ to 10″

Insect.	Stage in Life-history.	General Character of Soil.	Approximate Depth of Insect in Soil.
Cryptohypnus riparius, F.	larva, pupa, (imago)	Clay loam	surface, imago under stones
Melanotus rufipes, Hbst.	,,	Decaying wood in soil	,,
Agriotes lineatus, L.	,,	Clay loam (roots of grass)	,,
Corymbites pectinicornis, L.	,,	Clay loam (roots of grass)	,,
Campylus linearis, L.	,,	Clay loam (roots of grass)	,,
Telephorus fuscus, L.	larva, pupa	Sandy and clayey, under stones, and among vegetable refuse	surface to 6″
Telephorus darwinianus, Shp.	,,		
Anaspis frontalis, L.	,,	Sandy loam	surface
Otiorhynchus picipes, F.	larva, pupa, imago	Sandy loam, sod	surface, 3″ to 6″
Otiorhynchus sulcatus, F.	,,	,,	,,
Exomias araneiformis, Schr.	,,	,,	,,
Barynotus obscurus, F.	,,	Sandy and clayey loams, sod	,,
Diptera.			
Cecidomyiidae (various species)	larva, pupa	Variable, mostly sod	surface
Sciara carbonaria, Mg.	,,	Humus and loam	surface to 8″
Bolitophila cinerea, Mg.	,,	Humus and decaying wood	surface
Scatopae rotata, L.	,,	Decaying vegetable matter	,,
Dilophus febrilis, L.	,,	Sandy loam, sod	,,
Bibio hortulanus, L.	,,	Sandy loam	,,
Bibio laniger, Mg.	,,	,,	,,
Bibio Johannis, L.	,,	,,	,
Dicranomyia chorea, Mg.	,,	Clay loam	surface to 6″
Trichocera hiemalis, De G.	,,	Decaying vegetable matter	surface
Pachyrrhina imperialis, Mg.	,,	Clay loam	surface to 6″
Tipula oleracea, L.	,,	Moist clay loam	surface to 12″
Rhyphus fenestralis, Scop.	,,	Decaying vegetable matter	surface
Microchrysa polita, L.	,,	Decaying vegetable matter	surface to 6′

Insect.	Stage in Life-history.	General Character of Soil.	Approximate Depth of Insect in Soil.
Leptis scolopacea, L.	larva, pupa	Moist humus soil covered with loose grass, also in loam at roots of grass	surface to 6″
Thereva nobilitata, F.	,,	Light sandy loam	,,
Rhamphomyia nigripes. F.	,,	Decaying vegetable matter	surface
Dolichopus aeneus, De G.	,,	Sandy loam	,,
Platychirus albimanus, F. Syrphus grossulariae, Mg. Syrphus ribesii, L. Syrphus luniger, Mg. Syrphus scutatus, Mg.	pupa	Variable, but generally in light, dry soil. The larva enters the soil to pupate near plant where it has been feeding on aphides and generally in not too exposed situations	,,
Onesia sepulcralis, Ztt.	larva, pupa	Clay loam, sod	,,
Pollenia rudis, F.	,,	,,	,,
Myiospila meditabunda, F.	,,	Decaying vegetable matter	,,
Fannia, sp.	,,	Sandy loam	,,
Hyetodesia incana, W. Hyetodesia populi, Mg.	,,	Loamy soil, sod	,,
Hydrophoria linogrisea, Mg.	,,	Vegetable refuse	surface to 6″
Anthomyia radicum, L.	,,		
Pegomyia hyrscyami, Panz. Pegomyia bicolor, W. Pegomyia nigritarsis, Ltt.	pupa	Variable, depending on the situation of food-plant in the leaves of which larva mines. Here in light loam	surface
Scatophaga suilla, F. Scatophaga stercomaria, L. Scatophaga merdaria, F.	larva, pupa	Decaying vegetable matter	surface to 12″
Spilographa zoë, Mg.	pupa larva mining in leaves of groundsel	Variable	surface
Palloptera parallela, Lw.	larva pupa	Vegetable refuse	,,
Opomyza germinationis, L.	,,	Sandy loam	,,
Borborus equinus, Fln.	,,	Sandy loam, decaying animal and vegetable matter	,,

Insect.	Stage in Life-history.	General Character of Soil.	Approximate Depth of Insect in Soil.
Sphaerocera subsultans, F.	larva, pupa	Animal and vegetable refuse	surface
Phora rufipes. Mg.	,,	Vegetable refuse	,,
Phora pulicaria, Fln.	,,	Animal refuse	,,
Hymenoptera.			
Dolerus gonager, Fab.	pupa	Sandy loam & humus	surface to 8″
Dolerus haematodes. Schr.	,,	,,	,,
Dolerus picipes, Klug.	,,	,,	,,
Myrmeca rubra	all stages	Variable	surface

In the compilation of the above table I have to express my deep indebtedness to Mr. Edwards, Assistant, Natural History Museum, London, and to Mr. Collin, Newmarket, who kindly identified or corroborated various species of the Diptera; to Mr. Riley, Assistant, Natural History Museum, for his assistance with certain of the Noctuid larvae, and also to Mr. Hardy, Assistant, Manchester Museum, who was ever ready with his help whenever species of the Coleoptera were in doubt. The collections of British insects in both the Natural History Museum, London, and in the Manchester Museum, proved of invaluable help and were frequently referred to. To Professor Hickson, my chief, who inspired and gave every facility for the successful accomplishment of the work, I can but inadequately express my gratitude.

6.—Parasitic Hymenoptera.

The life-history of an insect is incomplete until we know not only how it lives and upon what it feeds, how it transforms, and the duration of its various stages, but also what species prey upon it, and to which it furnishes sustenance in one or other of its stages. We are therefore right in our studies of the life-history of an insect in studying also the parasites that prey upon it. Thus I have considered it important that all parasites which emerged in the breeding cages from the soil insects collected in the grounds should be recorded, together with a note of the date of their appearance and the name of the host. These data have been arranged concisely as follows :—

Family Ichneumonidae.

Sub-Family Ichneumoniae.

Amblyteles armatorius, Forst. ... *Triphaena pronuba*, L., and *T. orbona*, Hufn., 8-5-12, 16-6-12, 25-5-12.

Phaeogenes sp. ... ... *Chrysopa vulgaris*, L.; 16-8-12, 23-8-12, 24-8-12, and several others on days following.

Sub-Family Cryptinae.

Phygadeuon vagans, Gr.	*Pteronus ribesii*, Scop., Sept. and Oct.

Sub-Family Ophioninae.

Exetastes cinctipes, Retz.	*Mamestra brassicae*, L., *Hadena oleracea*, L., 14-8-12, 17-8-12, 21-8-12, and one specimen emerging from the soil, 20-8-12.

Sub-Family Tryphoninae.

I. Homocidus dimidiatus, Schr. II. Homocidus tarsatorius, Panz.	*Platychirus albimanus*, F. I. 8-5-12: also 3-2-13 and 5-2-13, and during March, '13, from pupae kept in laboratory. II. 12-9-12 and following days; also during February and March '13, from pupae kept in laboratory. Larvae of *P. albimanus* fed on *Pterocallis tiliae*, the Aphis of lime trees.
Perilissus filicornis, Grav.	*Dolerus picipes*, Klug, 21-5-12.

Family Braconidae.

Sub-Family Microgastrinae.

Apanteles sp.	*Agrotis segetum*, Schiff., 8-4-12, 17-4-12, 18-4-12, 3-5-12. Numerous.
Apanteles glomeratus, L.	*Pieris rapae*, L., Aug. '12.

Sub-Family Meteorinae.

Meteorus sp.	*Triphaena pronuba*, L., 7-4-12 and following days in March, '12. Numerous.
Opius nitidulator, Rees	*Pegomyia hyoscami*, Panz. From July 25th to August 23rd '12. Numerous.
Opius anthomyiae, Ashm.	*Pegomyia bicolor*, W. July 10th to Aug. 25th '12. Numerous.

Family Proctotrypidae.

Proctotrypes sp.	*Nebria brevicollis*, F. larva, 16-9-12.
Proctotrypes sp.	*Pegomyia hyoscyami*, Panz., 14-8-12.

Family Chalcididae.

Chalcid sp.	*Pegomyia hyoscyami*, Panz., 20-8-12, 22-8-12.
Chalcid sp.	*Pegomyia bicolor*, W., 24-8-12, 25-8-12.
Chalcid sp.	*Spilographa Zoë*, Mg., 8-4-12, 9-4-12, 16-4-12.

Family Cynipidae.

Figites scutellaris, Rossi	Muscid puparium from soil, unidentified; 17-5-12.

Besides these, a Tachinid, *Exorista agnata,* Rnd., was reared in abundance from pupae of *Abraxas grossulariata,* L., the Gooseberry Moth, collected from surface soil adjoining some gooseberry bushes. The first parasite emerged May 31st, 1912, and numerous others during the beginning of June.

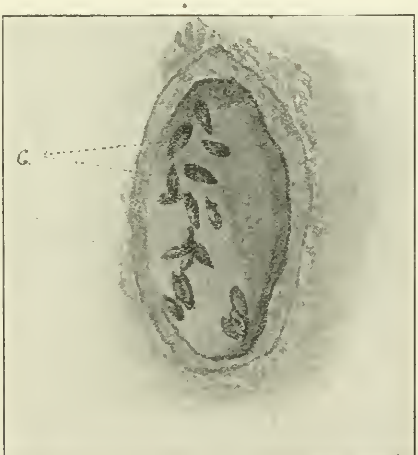

Fig. C.—Parasites of *Triphaena pronuba.*

The two species of Bassid Ichneumonidae, *Homocidus dimidiatus* and *H. tarsatorius,* had not previously been recorded from the Syrphid host, *Platychirus albimanus,* and I ('13) have published a note on this occurrence. The fully mature larvae of the Syrphid enters the soil to pupate, and the pupae are generally found two or three inches beneath the surface, but also frequently on the surface, under decaying grass, during the summer and winter, the insect being double-brooded.

The caterpillar of *Triphaena pronuba*, the Yellow Underwing, was parasitised by an Ichneumen, *Amblyteles armatorius*, Forst., and by a Braconid, *Meteorus*, sp. The *Amblyteles* is, according to Morley ('03, vol. i, p. 200), one of our commonest Ichneumons, and has been bred in Britain from various other species of Lepidoptera, including *Vanessa atalanta, Saturnia carpini, Laxiocampa rubi, Notodonta camelina*, early in June; *Agrotis segetum* and *A. ashworthii, Noctua xanthographa*, in July.

The *Meteorus*, sp. (fig. 33, cocoons) occurred very abundantly, and about ten per cent. of the larvae of *T. pronuba* were parasitised by it. In many cases as many as thirty to forty parasites emerged from the evacuated skin of a single larva. In each instance the larva had previously made its earthen cell preparatory to pupating (fig. 32).

Exetastes cinctipes, of which three specimens were reared, two from larvae of *Mamestra brassicae*, and one from the larva of *Hadena oleracea*, is said by Morley ('08, vol. iii, p. 295) to be the commonest species of all the Ichneumonidae in Britain, but, he adds, its economy was for a long time unknown. He quotes Curtis ('60, p. 130), who says: "It is difficult to account for the absence of surface-caterpillars from our field crops for many years together, unless, as is generally the case, they are occasionally overpowered by parasitic insects; it is therefore not a little remarkable that I have never met with any of the parasites which we may presume are attached to these caterpillars; it is true that, as far as regards the *Noctua brassicae*, I find in gardens in June and July great numbers of an ichneumon, called *Extastes osculatorius* of Fabricius (' syn. for *E. cinctipes*, Retz.'), which appears to accompany that species, but, never having bred it, I have no direct evidence of their being connected in their economy." Since then, *E. cinctipes* has often been reared from both *M. brassicae* and *H. oleracea*.

The species of *Phaeogenes* which occurred prevalently as a parasite in the cocoons of *Chrysopa vulgaris*, was not determined, and, on referring to Morley ('03, vol. i, p. 243), I find that there is no previous record of any species of this genus being reared from any member of the Neuroptera. He says: "The insects of this genus, with one or two unauthentic exceptions, are parasitic upon quite small Lepidoptera, and they have more especially been bred from Psychids, notably *Psyche viciella* and *P. ritidella*." The *Chrysopa* in question, of which numerous cocoons were found embedded in about three inches of soil around the bases of lime trees, preyed in their larval state on the same species of Aphid, *Pterocallis*

tibiae, which was also the food of the Syrphid larva, *Platychirus albimanus*, mentioned above. The *Phaeogenes*, sp., is fully developed and ready to emerge in the beginning of May, but several appeared much earlier, during the months of February and March, in the laboratory breeding cages. Empty cocoons are readily recognised as having been parasitised by the presence of a neat, small, circular aperture, through which the adult ichneumon makes its exit. Where the *Chrysopa* is not parasitised, the cocoon splits near the middle, round the circumference, and a small lid-like capsule usually remaining attached by a sort of hinge is pushed up by the emerging adult. In some cases it may become a question as to whether these Ichneumon parasites are really beneficial, for here, at least, the *Chrysopa*, which is of great assistance in very materially keeping in check the Aphid pest, must have its numbers sadly depleted. The same holds good in the case of the Syrphid, *P. albimanus*, and, were it not for these two useful species, the lime trees in the grounds of the Experimental Laboratory would suffer to a much greater extent from Aphid injury. But perhaps it would be more reasonable to consider this interrelationship between the Aphid and its enemies the Syrphid and Chrysopid on the one hand, and the Syrphid and Chrysopid and their parasitic Ichneumon on the other, as but an example of how nature carefully preserves a balance which provides against the total extinction of any one species. Thus, were the Syrphid and Chrysopid given unrestricted opportunity, they would multiply out of all measure at the expense of their host, the Aphid, until the latter was wholly exterminated. When this extreme result of their rapacity had become an accomplished fact, then they too would also become extinct, unless, indeed, they had sufficient mobility of habits to transfer to another species of host. But a limit to this possibility is presented in the shape of the Ichneumon, which in its turn assists in keeping the Syrphid and Chrysopid within reasonable boundaries that vary, it is true, from year to year, but not to any very great extent. Thus the Ichneumon which, on first thoughts, might not appear to be serviceable, occupies a definite place in the economy of a benevolent nature which is always assiduously striving to maintain the all-important balance. Examples might be multiplied almost without end, and hyperparasitism, or a secondary, having for its host a primary parasite, is but another aspect of the same most absorbing subject.

One specimen of *Perilissus filicornis* emerged from a mature larva of *Dolerus picipes*—a species of what is known in America as the "Wheat Stem Fly"—which had entered the soil to pupate.

According to Morley ('11, vol. iv, p. 255) this species occurs with considerable frequency in northern Europe, in Italy, and probably through the palearctic region, and further he says: "Brischke alone appears to have bred it (Schr. Phys. Ges. König, 1871, p. 69), and he found it emerged from the larvae of *Nematus latipes*, of *N. fraxini*, of *N. erichsoni* ('larch-sawfly'), and from those of an unnamed species of *Dolerus*, in Prussia."

Of the remaining parasites which were reared, the Braconid, *Opius nitidulator*, which has frequently been bred from the puparia of *Pegomyia hyoscyami* and *P. betae*, must have acted as an efficient check on the first of these leaf-miners. The Dipteron is double or triple-brooded, and the second or third brood of maggots which are actively engaged feeding on the leaf parenchyma of the Belladonna (*Atropos belladonna*) in the end of August and beginning of September, is most heavily parasitised. Collecting thirty of the hibernating puparia at random from the soil, I was successful in rearing twenty-eight adult Braconids, the remaining two puparia proving abortive. An allied species, *Pegomyia bicolor*, mining in the leaves of the Dock, *Rumex Crispus*, had for a parasite *Opius Anthomyiae*, closely related to *O. nitidulator*, and both *P. hyoscyami* and *P. bicolor* were also abundantly parasitised by Chalcids.

Altogether, two specimens of Proctotrypids, representing two species, one from the larva of *Nebria brevicollis*, and the other from *P. hyoscyami* were reared, and one specimen of a parasitic Cynipid, *Figites scutellaris*, emerged from an undetermined Muscid puparium extracted from the soil.

This section would be incomplete were I not to thank Mr. Morley, Natural History Museum, London, for his kind aid in the naming of many of the parasites which were reared in the course of the work, and are here discussed.

Two Cases of Thigmotropism.

Two curious instances of *thigmotropism* came under my notice, and in both cases the phenomenon was of the less general positive kind. Larvae of *Boletophila cinerea* were found to occur abundantly in the soil beneath a decaying tree-trunk, living gregariously in dense patches, and this same social mode of behaviour prevailed with a species of Sciarid larva (*S. Thomae* ?), great numbers of which had their habitat in soil covered over by the remains of former vegetation. The latter species were also often encountered in small masses at the roots of grass, on which they were in all likelihood feeding.

Reaction to contact stimuli is not uncommon in the Mycetophilidae, to which family of Diptera the two above-mentioned species belong. Theobald ('01, p. 106) states that in one species, *Sciara thomae* [*S. militaris*, according to Beling ('83, pp. 253-271)], the thigmotropic phenomenon is developed to such an extent that in Germany, Sweden, Russia and America long columns of the larva are seen advancing over the surface of the ground in compact formation. Consequently it has earned the suitable name of "Army Worm," or "Heerwurm" of German authors. Theobald goes on to say that at certain times of the year large companies of this *Heerwurm* migrate in a long procession, sometimes as much as fourteen feet in length, and two or three inches wide, and may be half-inch thick, this dense layer of larvae containing some millions of individuals, sticking close together, and crawling over and over one another.

One can easily understand how this gregarious habit would present a ready means of destruction if the insect should prove a pest. Any efforts at eradication could be concentrated over a small area with the most effective results.

Positive *thigmotropism*, although less common than negative, is quite general amongst soil insects, which squeeze themselves into crevices until their bodies come into close contact with surrounding surfaces. The fact that gravity (*geotropism*) and light (*phototropism*) also serve to control the direction of locomotion of an animal somewhat complicates matters.

PART II.

SOIL INSECTS AND THE PHYSICAL CONDITIONS OF THEIR HABITAT.

1.—Introduction.

We may take it as a general rule that the conditions in the soil which are most favourable to plant life, are also those which are most beneficial to the vital processes of all animal organisms which have made it their home. Within the grounds at Fallowfield there is a deep substratum of very dense clay, and it would seem that where the clay is covered over by a loamy surface soil fairly good conditions are offered to subterranean insect larvae and pupae, but on the whole burrowing insect larvae generally avoid a heavy, tenacious soil,

owing to the difficulty which they experience in tunnelling their way through it, and the consequent check to their activities. Their favourite habitat, and one in which they undergo their metamorphoses most successfully, would appear to be a rich loam composed of clay mixed with fine sand, where the latter is present in such proportions as to allow of water percolating through the mass and to prevent its binding together. Wireworms and leather-jackets do not seem to object to a stiff clay soil, which offers little, if any, effectual hindrance to their slower movements. Again, unlike the larvae of the predaceous Carabidae and Staphylinidae, they have no absolute need to wander about when their food plant is plentiful and at hand. Indirectly also the presence of a clay substratum is not unfavourable to vegetarian insect species such as wireworms and weevil grubs. Preserving, as it does, the useful products of decomposition of manures, and being, further, rich in alkaline salts, potassium, calcium, and magnesium, which are essential for the successful growth of plant life; crops flourish on it to such an extent —other things being equal—as to offer ideal conditions to insect pests.

If subterannean insects are to thrive they require, amongst other things, a plentiful supply of air for the oxygenation of their tissues. Thus any factor which tends to keep the texture of the soil loose and open will also favour the survival of its insect denizens. In pasture land deep-rooted plants such as burnet, chicory and yarrow are useful in opening up the soil, admitting air, which is at once advantageous to the healthy development of the roots of other plants and to the physical well-being of soil insects present in its recesses. As a proof of this fact it may be stated that attempts to rear the imagos of various insects collected from the soil are often unsuccessful in the laboratory. If the soil in the breeding cages becomes stale, and its surface bound together so that there is no free access of air, larvae invariably die off, the species of active Carabid larvae, for instance, being more susceptible to the injurious effects of this deficiency than Dipterous maggots or weevil grubs. If, however, the soil is disturbed at intervals so that air can penetrate easily, better results are obtained, as was shown by the larger proportion of insects that completed their metamorphosis in the laboratory breeding cages. From this we might deduce the conclusion that a loose, open soil would be favourable to destructive species as well as beneficial, and while I maintain this in the cases which I have had the opportunity of observing, yet it often happens that serious outbreaks of wireworm and leather-jackets are associated with a

heavy clay soil. Indeed, facts serve to show that leather-jackets, at least, prefer moist, damp situations.

When ready to pupate soil insect larvae generally burrow a little way beneath the surface, some further than others. Of all those observed in the grounds, *Hepialus humuli,* the Ghost Moth, which in the larval state was found to be feeding principally on the big, strong roots of cock's-foot grass, went deeper down than any others. In some cases the earthen chamber containing the pupa occurred eighteen inches below the surface, in the subsoil.

2.—Soil Insects and Soil Moisture.

That water is the supreme agent in determining the degree of fertility of the soil, and is all-important to the vital functions of the plant in its capacity of feeding and carrying food to it, is well known, but in how far it influences other kinds of terrestrial life beneficially or detrimentally has not been fully ascertained. In the laboratory of the soil water may exist in three distinct forms, which Lyon and Fippen (p. 141) explain as follows :—

"1. Gravitational water which percolates through the soil under the action of gravity.

2. Capillary water which is held by surface tension against the action of gravity.

3. Hygroscopic moisture, which condenses from the atmosphere laden with moisture on the surface of the particles of an air-dry soil."

Of these three, gravitational water is the most abundant variety, and the one which is destructive of insect life within the confines of the soil. Capillary moisture, on the other hand, keeps the soil just in the right condition favourable to its fauna, whilst hygroscopic water, on account of its infinitesimal amount, has practically no significance in questions pertaining to soil insects. The latter experience the most precarious time of their existence during the winter and spring, when, owing to heavy and protracted rain showers, there is an abundance of gravitational water present in the soil, the spaces between the grains being completely filled with water, all air being expelled. Where these conditions are maintained for a fairly long time the larvae and pupae of Coleoptera and Diptera, which undergo their metamorphosis in the soil, are practically killed by suffocation, and, further, the very humid conditions induce liability to attack by fungi, the spores of which are present in all soils. The physical conditions of the soil determine the amount of gravitational water which it will hold; the larger the pore space, and therefore

the smaller the particles, the greater the quantity retained. Hence it is that clay soils do not allow of its percolating so quickly as a loose, sandy soil, and this, added to the fact that the capillary capacity of clay is much greater than that of any other kind of soil, gives the former its generally moist appearance. Thus it will be readily understood why a clay soil is generally shunned by soil insects, especially the more active sort, because, besides its impenetrability, it has also the fatal disadvantage—from the insect point of view—of imbibing and retaining too much water. While nature to some extent aids in the checking of soil pests by soaking the ground with rain, artificial methods of flooding infested areas have been advocated for combatting surface caterpillars, leather-jackets and wireworms. Fields which are being ravaged by their operations are kept under water until it is certain that none have escaped drowning. But this radical method would not always be practicable, because flooding for such a time as would ensure the removal of the pest would in many cases undoubtedly mean the sacrifice of the crop also. In regard to wireworm, Curtis ('60, p. 175) says: "It thus appears evident that any endeavour to destroy the wireworms is almost impracticable; for they not only exhibited signs of life in water for four days, but I think it is probable that if a field were laid under water for a much longer period, it would not destroy them." I myself have kept specimens of the larvae of *Agriotes lineatus,* our commonest wireworm, in water for as long as six days without their being drowned, but those which were thus treated for a period of seven to eight days did not generally recover from the deleterious effects of their immersion. Leather-jackets and surface caterpillars submitted to the same treatment succumbed in a much shorter time, one to two days for the caterpillars, depending on their state of development—much shorter than this for the very young forms—and from one to three days in the case of leather-jackets, the latter in all cases being fully mature.

Irrigation as a means of fighting insect pests has been advocated and utilised by many American entomologists, as well as by French viticulturists. Riley and Howard ('90, p. 220) have discussed the effect of inundating the great arid plains of the North-west of America as a method of destroying the native breeding grounds of the devastating Rocky Mountain Locust, *Melanoplus spretus,* at the same time converting the desert into fertile fields and redeeming the waste places of earth. Dealing with the Chinch Bug, *Blissus leucopterus,* an important pest of corn in the States, Howard says: "This insect is directly influenced by moisture, and seldom

occurs in numbers in the more eastern States, except after two or more successive seasons of drought. After a year of excessive multiplication these insects will often be found to have hibernated in immense numbers, and it is a well-known fact that heavy rain-falls will destroy them almost completely. This being the case, an artificial system of irrigation will enable the agriculturist to hold the insect completely in check." Submersion has also proved of great value in the case of the Grape-Vine Phylloxera, *P. vastatrix*, in France. Riley, quoted by Howard ('90, p. 221), says that where it is practicable, and where it is totally and sufficiently prolonged, this method is a perfect remedy, excessive moisture being very disastrous to the lice. An anonymous author ('94, p. 317) states: "Wherever this method of controlling the Phylloxera has been introduced, often at considerable outlay, there has been no thought of abandoning it, and in no case have any of the injurious results which were feared from it at the outset been realised. For instance, the soil has not been appreciably changed in character by the loss of constituent elements, or at least not more than can be easily replaced by suitable fertilisers; nor has there been any packing or other physical changes injurious to vine growth."

The presence of capillary water is most important for soil insects, and, if there should happen to be any great diminution in its amount owing to long periods of drought, the consequences may prove fatal; or at least its absence has the effect of driving them down into the subsoil away from the root zone. When the top layer of soil is loosened, as, for example, when it is hoed or harrowed, capillary water is lost in large quantities, and under the drying action of wind and sun the disturbed part becomes air dry. Springtails, which frequent the surface, are then killed off, but active, burrowing soil insects contrive to reach the deeper layers. For while there is a decided loss of moisture at the surface, the loose formation tends to a greater conservation of water in the subsoil, owing to the discontinuity established in the capillary tubes preventing its upward movement. By breaking up and exposing the soil to the effects of drought in this way, any relief that may be expected from the attacks of noxious soil pests will only be temporary, for with the first heavy shower of rain connection is re-established between the soil and subsoil, and the insects return once more to the surface and to their work of destruction.

By alterations of the texture and structure of the soil in a purely mechanical manner, injurious soil-inhabiting insects may be kept under control. Thus, a heavy roller drawn over the ground causes

wireworms, owing to the heavy pressure exerted, to descend into the subsoil. The compacting of the soil also prevents the pest from preying on the tender roots of young crops, such as corn and wheat. But changes in the facies of a soil may lead to injurious results to the vegetable life which it supports. If we consider the effects produced by rolling, we see that in a loose soil the porosity will be destroyed. This destruction of the air channels tends to increase evaporation, so that a crop would lose much moisture which it would otherwise have been able to utilise. But if the soil operated upon be one subject to excessive leaching, pressure will compact the subsoil into a more dense mass, and consequently there will be a slower downward movement of the water, which is therefore detained for a longer time in the root area, to the advantage of the crop. In the latter case, then, rolling is beneficial in conserving moisture and in driving noxious pests into the subsoil. It depends, then, on the texture of the soil and its capacity for water what course the agriculturist will adopt in combatting wireworms. The advantages must always be set off against the disadvantages to the crops, and in proportion as the ones outweigh the others, the plan of attack must be devised. Where the depredations are intense, the old method of paring and burning must be resorted to, which, in other words, means the sacrificing of the crop. It is to be hoped, however, that a more effective and less expensive way of dealing with this noxious pest may soon be found.

Curtis ('60, p. 176) says that common salt on light sandy soils is advantageous in destroying wireworm and Cockchafer grubs. Other alkali salts have also a deleterious effect on all kinds of soil insects, and have, further, an added advantage in that they increase the surface tension of the soil moisture above that for pure water. The soil is thus enabled to draw and to retain permanently more water than the adjacent soil of like texture. The various alkali salts, magnesium chloride, potassium sulphate, ammonium chloride, and ammonium sulphate, are also of great use in their capacity as fertilisers. Therefore, besides being efficacious in their physiological action against pests, these salts help to preserve a larger moisture content for plants, whilst at the same time contributing constituents necessary for their successful growth.

3.—Their Relation to Temperature.

There is no physiological fact more evident than the extreme importance of maintaining the right temperature surroundings for living forms of all kinds. Amongst insects, and especially in

those which inhabit the soil, the admissible range of variation of temperature may be quite considerable without seriously interfering with their activities. A high soil temperature, in that it stimulates the more rapid diffusion of gases, aids in a more perfect soil aëration, which is important in its invigorating effects upon all life, both animal and plant, in the soil. As regards low temperatures, the majority of hibernating insects practically bid defiance to cold, if it should come at the proper time, and not take them unawares. The ground-beetles and surface-caterpillars which hibernate as larvae, generally entrench themselves deeply in the subsoil previous to the onset of winter. By contriving to get deep down they escape from the frost-bound surface, which would grip them in effective imprisonment and prove fatal to them. But such is the tenacity of many larvae that even hard frosts fail to terminate the life processes and only produce lethargy. Caterpillars of *Triphaena pronuba* and *Agrotis segetum,* as well as the maggots of some Muscid Diptera, *Scatophaga suilla, S. stercoraria, S. merdaria,* and *Hydrophoria linogrisea,* which were gathered from a frost-bound soil in the month of February, 1912, quite recovered from their congealed condition on being taken into the warm laboratory, and there they successfully completed their metamorphoses. The cold of winter is a most necessary factor for the normal development of many species which hibernate in the larval and pupal states, and, to take but a single example, I have observed that imagines of *T. pronuba* which have emerged from pupae kept in the laboratory during the winter months, are decidedly inferior to, and less robust than, those wihch have been subjected to natural conditions. It is the unseasonable colds of early autumn and of late spring which play havoc with soil insects when the hibernating stage has not been yet reached or has just passed. Anent this, it may be of interest to quote Professor Sorauer ('06, p. 8), who says: "Kalte schadet, im Gegensatze zur herrschenden Ansicht den meisten Tieren nicht, wenn sie zur richtigen Zeit kommt, also dann, wann diese ihr Überwinterungsstadium erreicht haben, and wenn sie richt eine Höhe erlangt, die für die betreffende Breite abnorm ist." Whilst dry cold, then, does little or no damage to the majority of soil insects, provided it arrives at a seasonable time, wet cold is one of their worst enemies. When the soil, thoroughly soaked by frequent heavy rains, freezes hard, thousands of the insects hidden under its cover are killed off, partly by suffocation or by direct freezing. If the body juices be in a very concentrated condition there is less chance of fatal consequences than if they be very dilute. To chemists it is a well-known

fact that the freezing-point of a solution is lowered in proportion to the amount of solute which it contains, and this may partly explain why some soil insects appear to be little affected by cold, the fluids which bathe their tissues being so concentrated as to prevent the fatal results of freezing.

A sudden falling of the temperature in summer has the effect of sending soil insects into an inactive sluggish condition, when they cease to partake of food. This is more accentuated in the case of winter cold, when few make much progress with their development, although many Dipterous maggots, which breed amongst manure or decaying vegetable substance, continue to feed and grow. Fermentation, which is the natural accompaniment of decay, generates heat, and so a sufficiently high temperature favourable to the ingestion of food is maintained. The warm rains of spring, together with the increased amount of heat imparted to the soil, constitute a powerful impetus to all soil insect life. Temperature relations, as has been previously remarked, are closely associated with the physiological processes of animal life, which are essentially chemcal in their nature. The changes going on in the larvae and pupae, which result in the various phenomena of metamorphoses, require that the materials which react upon one another should first be raised to a certain temperature, should have a certain molecular swing, before it is possible for the changes resulting in the appearance of the adult insect to take place.

The temperature of the soil varies according to the depth, the greater the depth, the lower the temperature; but the decrease is by no means a regular one, and is larger during some months than others. Taking the first twenty-four inches of soil, I found that there was on an average a difference of about 2°-3° F. between the temperatures at depths of three and twenty-four inches during the months October to April, whilst from May to September the difference amounted to as much as 4°-6° F., reaching a maximum of 6° F. in July. In the month of September the average temperature for the first three inches was 61.3° F.; at a depth of twenty-four inches the average was 63.6° F., so that, contrary to the general rule, there was an increase of temperature recorded with an increase of depth. Temperatures below 40° F. in the soil have a decided effect on insect life, which assumes a lethargic condition, accompanied by a cessation of all vital activities. Insects which are one day quite alert in their pursuit of prey, or busily engaged assimulating their food, and, in the case of the larval Carabidae and Staphylinidae which burrow quickly out of sight when disturbed, may the next day, with a

lowering of temperature below 40° F., be rendered entirely *hors de combat* and quite unable to stir.

That varying weather conditions have an important bearing on various insect pests which appear to be more prevalent in some years than in others, is more than probable, and I am sure that definite meteorological observations carried out in association with entomological work would solve many intricate questions relating to the sudden outbreaks of pests, such as leather-jackets and wireworm,—epidemics of which are often confined locally to quite small districts. Sorauer ('06, p. 10), quoting Alisch, who has published an account of his observations on the influence of wet years on insects, particularly the Coleoptera, says: "Von grösster Wichtigkeit sind danach die Monate Mai bis Juli, weil sich in ihneu die meisten Insekten im Eier-oder Larven zustande befinden, die gegen Nässe ganz besonders empfindlich sind. Steigt in diesen drei Monaten zusammen die Zahl der Regentage auf über 30, so ist nach ihm die Käferernte im nächsten Jahre schlecht." Further, quoting Altum, he adds: "Auch Altum betont die verderbliche Wirkung nasser Frühjahre auf das Insektenleben durch die Empfindlichkeit namentlich der vor dem Ausschlupfen stehenden Eier und Puppen." The composition of the insect fauna of a district is undoubtedly dependent on the local weather conditions and other factors, such as kinds of soil and cultivation, and I fully agree with this same author when he says: "Das Klima einer Gegend ist bestimmend für die Zusammensetzung seiner Fauna; von den genaueren Beziehungen wissen wir nur sehr wenig. Von grösserer Bedeutung sind wohl die Summe der Jahrestemperatur und die mittlere Temperatur während der heissesten Zeit, ferner die Niederschlagsmengen. Wie diese Grössen ständig wechseln, so ändert sich auch ständig die Fauna einer Gegend. Von allen Seiten wandern stets neue Elemente ein, je nachdem sich das Klima gerade dem ihrer Heimat nähert, um bei entgegengerichteten Schwankungen wieder zu verschwinden."

"Auch Boden—, Anbau—, und ähnliche Verhältrisse sind bestimmend für die Fauna einer Gegend."

Terrestrial insects are very often found to occur in great numbers under stones, tree-stumps, and felled trees; also under boards, decaying leaves, and, in fact, under anything left on the surface of the ground. The presence of such protective coverings, which are nothing more or less than mulches on a small scale, reduces a too rapid evaporation, the surface moisture vaporising into the atmosphere of the closed chamber below the cover, and keeping it saturated. Dry air, which would cause a progressive loss of moisture

by removing this vapour, is excluded, and the temperature being thus kept more equable many soil insects, such as the larvae of Leptidae and Therevidae, besides those of many Muscidae and Anthomyiidae and various species of Coleoptera, seem to find under these shelters conditions congenial to their welfare. That soil insects are indeed attracted by any waste material left lying on the surface is well known, and at Fallowfield I have taken advantage of this fact in collecting various species, the larvae of the two species of *Telephorus, T. fuscus* and *T. darwinianus,* being taken in large numbers under an old canvas bag. Agriculturists employ the method of covering the surface of the ground to conserve the soil moisture gathered in during the autumn and winter, so that the crops which are sown in the spring may start off with a sufficient supply of water. Artificial mulches are not generally employed at the present day, a more satisfactory way being to keep the top few inches of soil in a loose, open condition, which has the effect of interrupting the capillary passage of moisture to the surface, and thus checking evaporation. But where it is desirable to get rid of soil insect pests, the use of artificial coverings are often advantageous, and besides serving as efficient traps they aid, as has just been said, in the conservation of moisture.

It would be rather interesting to know why it is that some soil insects occur more prevalently in soils of a dark colour, while others show a decided preference for those which are of a light hue. The larvae of Coleoptera are generally found to carry on their operations in dark-coloured soil, including those of Carabidae and Staphylinidae, *Sphaeridium, Cercyon*, and also those of Elateridae and Rhynchophora. Most Dipterous burrowing maggots show a like tendency, while the larvae of Tenthredinidae, as, for example, the species of *Dolerus* which pupate in the soil after becoming full-grown prefer soils of a light colour. It is probable that the colour itself is only of secondary importance to what imparts the colour and to the conditions due to the colouring substances. Humus, for instance, and the accompanying organic acids always give a black appearance to soils, which are thus enabled to absorb the heat rays of the sun to a much greater extent than those where it is absent. But the consequent increase of temperature, due to the greater heat absorption, may be more than counteracted by the fact that in such soils the percentage of water is usually high, which, owing to the high specific heat of water, has the effect of reducing the temperature. It may be, therefore, that these two factors, temperature and moisture, creating a sort of balance, offer more equable conditions to insect life than obtain in light-coloured sandy soils. And yet species

of fossorial wasps, which make earthen galleries for the deposition of their eggs and for the storing of provender for their larvae, select a sandy soil for their operations, easy to work and exposed to the sun. As Fabre, in his delightful work, "Insect Life" (p. 52), remarks: "The only indispensable condition seems to be that the soil should be dry and exposed to the sun for the greater part of the day." As I have not had the opportunity of investigating the behaviour of these, we might almost say sagacious, insects, I cannot pass any definite opinion on the conditions which are most favourable to them. Again referring to the habitat of the various species of *Bembex*, the same author goes on to say: "The soil unoccupied by any woody vegetation is almost bare, and composed of a fine, arid, very light sand, heaped by the wind in little hillocks, where the stems and roots of the ilex hinder its blowing about. . . . At a certain depth, varying according to the more or less recent date of the last rains, the sand retains a dampness which keeps it stable, and lends a consistency allowing of slight excavations without roof and walls falling in." The conclusion seems to be, then, that it is the texture of the soil which is the most important condition in determining the abode of these Hymenoptera, a light sandy soil which can be excavated quickly, and yet retaining sufficent moisture below the surface to lend to the galleries a certain firmness, and to safeguard the soft-bodied larvae from being injured by the heat of the sun.

4.—Their Relation to Soil Ventilation.

A high soil temperature, in that it stimulates the more rapid diffusion of gases, aids in a more perfect soil aëration, which is important in its invigorating effects upon all life, both animal and plant, in the soil. Oxygen is a very necessary constituent of soil air, assisting as it does in the formation of plant food from the organic matter present, and being most important for the germination of seeds and the growth of plant roots. No less important is it for the successful development of insect life, more so, if anything, in the larval feeding than in the resting pupal stage. Insect larvae have, however, a wonderful power of adapting themselves to adverse conditions, and maggots of Muscid Diptera especially can survive the absence of oxygen for quite long periods. It may be interesting to mention in this connection the remarkably tenacious grasp which many of them have on life, and, within certain limits of time and treatment, they show a delightful unconcern to changes in their environment, often suffering no injurious effects in their subsequent

development. This fact first appealed to me while I was engaged on the life-history of *Louchaea chorea,* Fab. ('13), when I noticed that the larvae, after being subjected to long periods of submersion, recovered its normal activity almost immediately after its removal from the water. Farsky ('79, p. 103) subjected the larva of this same species to more radical treatment, replacing the water by various strengths of alcohol, and even after being placed in a watch-glass containing absolute alcohol, which was allowed to evaporate, the larva continued to live. A faculty of resistance and power of adaptability to adverse circumstances is of peculiar advantage to the insect inhabitants of the soil, which, owing to the varying climatic and atmospheric conditions, are often subjected to most severe extremes of heat and cold, wet and drought. The more sluggish maggots of Diptera have a greater plasticity than the active larvae of predaceous Coleoptera. On considering these two orders by themselves, amongst Diptera the larvae of Muscidae have a greater power of resistance generally than the larvae of the Nematocerous and Brachycerous families, whilst amongst Coleoptera the grubs of Rhyncophora are not so easily affected as those of Carabidae and Staphylinidae and other active families. This is just what we might expect, seeing that nature, which has deprived Dipterous maggots and Weevil grubs of legs that they might readily escape from danger, has compensated them to some extent by endowing them with a greater power of resistance to adverse conditions. Thus they are enabled to survive in the struggle which is just as intense in the subterranean interstices of the soil, as in any other animal domain.

Soils that are of a light and open texture are, as we have already seen, the ones most frequented by soil insects, all other conditions, such as those of food, being equal. We might find an added reason for this preference when we consider soil ventilation, since loose, open soils are subject to peculiarly thorough breathing, while all close-textured soils, like the heavy and stiff clays, are naturally less perfectly aërated. A porous subsoil is also conducive to the well-being of insect life, in that the rain can quickly penetrate, and, as it passes through, air is drawn into the more superficial layers in order to take its place. Hence a reason why soil insects are only rarely found in the deeper subsoil; for the increased amount of moisture, together with the decrease in aëration, is decidedly detrimental to their activities. Considered in another way, questions of soil aëration are closely associated with the operations of soil pests. Take, for example, the case of a severe infestation of wireworms or leather-jackets; the damage that they commit directly by feeding

on the roots of crops, may be greatly accentuated by the loss of moisture which they cause by burrowing in the soil, thus opening it up and exposing a large surface to the effect of air movement, so that the water contained in the soil, which in the normal course of events goes to feed the growing plants, is lost. Where the rainfall is abundant the loss may not be an appreciable one, but during periods of drought this is a factor which enters seriously into the reckoning of the agriculturist. In some cases, and under certain circumstances, the application of artificial manures, such as lime, is advantageous in increasing the permeability of a heavy soil, and lime, used as a fertiliser, also renders the soil unsuitable to insect pests.

V.—BIBLIOGRAPHY.

The following works have been consulted :—

1893, etc. **Barrett, C. G.**—The Lepidoptera of the British Isles. 5 vols. London.

1904. **Beave, T. H., and Donisthorpe, H. St. J. K.**—Catalogue of British Coleoptera. London.

1872. **Beling, Th.**—Die Metamorphose von Rhyphus punctatus, F. und Rhyphus fenestralis Scop. Archiv. für Naturges., Jhg. 38, pp. 48-54.

1875. ———— Beitrag zur Metamorphose der zweiflügeligen Insecten. Archiv für Naturges. Jhg. 41, pp. 31-57.

1882. ———— Beitrag zur Metamorphose zweiflügeliger Insecten aus den Familien Tabanidae, Leptidae, Asilidae, Empidae, Dolichopidae und Syrphidae. Archiv. für Naturges, Jhg. 48, Hft. 2.

1883. ———— Der Heerwurm. Zeit. f. die ges. Naturw., vol. 46, pp. 253-271.

1911. **Bevis, J. F., and Jeffery, H. J.**—British Plants, their Biology and Ecology. London.

1834. **Bouché, P. Fr.**—Naturgeschichte der Insekten, besonder in Hinsicht ihrer ersten Zustande und Puppen, 216 pp., 10 pl.

1883. **Brauer, F.**—Die Zweiflugler des Kaiserlichen Museums zu Wien. Denk d. Kais. Akad. d. Wiss., pp. 1-99, pls. 5, 110 figs. Wien.

1886-1901. **Buckler, W.**—The Larvae of the British Butterflies and Moths. Ray Society. London. 9 vols.

1913. **Cameron, A. E.**—On the Life-history of Lonchaea chorea, Fab. Proc. Ent. Soc. London. 1 pl., 9 figs.

1913. ——— A Note on Two Species of Bassid Ichneumonidae Parasitic on a Species of Syrphid Larva. The Entomologist, April, pp. 130-131.

1882-93. **Cameron, P. A.**—Monograph of the British Phytophagous Hymenoptera. Ray Society, vols. 1-4.

1901-12. **Carpenter, G. H.**—Reports on Injurious Insects observed in Ireland. Econ. Proc. Roy. Dub. Soc.

1853. **Chapuis, M. F., et Candeze, M. E.**—Catalogue des Larves Coléoptères, Liège.

1909. **Collinge, W. E.**—The Rôle of Collembola in Economic Entomology. Journ. Econ. Biol., vol. 4, no. 3, pp. 84-90.

1909. **Collinge, W. E., and Shoebotham, J. W.**—Notes on some Collembolla new to Great Britain. Journ. Econ. Biol., vol. 4, no. 3, pp. 87-90.

1909. **Collinge, W. E.**—Observations on the Life-history and Habits of Thereva nobilitata, Fabr., and other Species. Journ. Econ. Biol., vol. 4, no. 1, pp. 14-18, 1 pl.

1910. **Collinge, W. E., and Shoebotham, J. W.**—The Apterygota of Hertfordshire. Journ. Econ. Biol., vol. 5, no. 3, pp. 95-132.

1910. **Collinge, W. E.**—Collembolla as Injurious Insects. Journ. of Econ. Biol., vol. 3, no. 2, pp. 204-5.

1910. ——— The Fauna of the Midland Plateau: a Preliminary list of the Thysanura and Collembolla. Birmingham Nat. Hist. Phil. Soc., Birmingham.

1911-12. **Collinge, W. E.**—Reports on Economic Biology, Birmingham.

1912. ——— A Manual of Injurious Insects, Birmingham.

1891. **Comstock, J. H., and Slingerland, M. V.**—Cornell Univ. Agric. Exp. Stat., Entom., Div., Bull. No. 33, Nov., 1891, and Bull. No. 107, Jan., 1896.

1824. **Curtis, J.**—British Entomology. London.

1860. ——— Farm Insects. London.

1901. **Fabre, J. H.**—Insect Life. London. (Translation).

1879. **Farsky, F.**—Die ersten Stände zweier Runkelrüben-Fliegen. Verhand. d. k. k. zool.-bot. Ges. Wien, pp. 101-113, 1 pl., 11 figs.

1903. **Forbes, S. A.**—Notes on Insectivorous Coleoptera. Bull. Ill. St. Lab. Nat. Hist., vol. 1, no. 3, pp. 167-176. (Second Ed.).

1888-91. **Fowler, W. W.**—British Coleoptera. London. 5 vols.

1866. **Frauenfeld, G. V.**—Zoologische Miscellen. xiv. (Metamorphoses of several species of Coleoptera and Diptera). Verh. d. k. k. zool.-bot. Ges., Wien.

1904. **Fream, W.**—Soils and their Properties. London. (Bell's Agricultural Series).

1873, etc. **Gerard, M.**—Traite Elémentaire d'Entomologie. Paris.

1904. **Hall, A. D.**—The Soil. An Introduction to the Scientific Study of the Growth of Crops. London.

1911. **Hall, A. D., and Russell, E. J.**—A Report on the Agriculture and Soils of Kent, Surrey, and Sussex. London.

1911. **Henrikson, K. L.**—Oversigt over de danske Elateridelarver. København Ent. Medd. 2 den Raekke, pp. 225-252, 32 figs.

1907. **Hewitt, C. G.**—On the Life-history of the Root Maggot, *Anthomyia radicum*, Meigen. Journ. Econ. Biol., vol. 2, pp. 56-63, 1 pl., 9 figs.

1910. **Hilgard, E. W.**—Soils; their Formation, Properties, Composition, and Relations to Climate and Plant Growth in the Humid and Arid Regions. New York.

1884. **Hooker, J. D.**—The Student's Flora of the British Islands. London.

1890. **Howard, L. O.**—Irrigation and Injurious Insects, Insect Life, vol. 2, pp. 215-222. Washington.

1894. **Howard, L. O.**—Control of Phylloxera by Submersion, Insect Life, vol. 2, pp. 315-318, 1 fig. Washington.

1895. **Judeich, J. F., u. Nitsche, H.**—Lehrbuch der Mitteleuropaïschen Forstinsektenkunde. Berlin.

1874. **Kaltenbach, J. H.**—Die Pflanzenfeinde aus der Klasse der Insekten. Stuttgart.

1910. **King, F. H.**—The Soil; its Nature, Relations and Fundamental Principles of Management. New York. (Rural Science Series).

1911. **Kraus, G.**—Boden und Klima auf kleinsten Raum. Versuch einer, exakten Behandlung des Standorts auf den Wellenkalk. Jena.

1888. **Lintner, J. A.**—Cut-Worms. New York State Mus. Bull. No. 6. Albany.

1862. **Loew, H.**—Die europaïschen Bohrfliegen (Trypetiden), Wien.

1907-08. **Lundbeck, W.**—Diptera Danica, pt. i ('07), pt. ii. ('08).

1909. **Lyon, T. L., and Fippen, E. O.**—The Principles of Soil Management. New York.

1895. **Meyrick, E.**—A Handbook of British Lepidoptera. London.

1903-11. **Morley, C.**—British Ichneumons. Plymouth. 4 vols.

1898. **Ormerod, E.**—Handbook of Insects Injurious to Orchard and Bush Fruits. London.

1890. ——— Manual of Injurious Insects. London.

1862. **Osten-Sacken, Baron.**—Characters of the Larvae of Mycetophilidae. Proc. Ent. Soc. of Philadelphia (reprint, 1886).

1877. **Perris, M. E.**—Larves de Coléoptères. Paris.

1911. **Russell, E. J.**—Lessons on Soil. Cambridge.

1862-64. **Schiner, J. R.**—Fauna Austriaca, Die Fliegen (Diptera). Wien. 2 vols.

1861-76. **Schrodte, J. C.**—De Metamorphosi Eleutheratorum Observationes, Naturhistorisk Tidsskrift. Copenhagen. 3 vols.

1910. **Sharp, D.**—Insects. Camb. Nat. Hist., 2 vols.

1893. **Smith, J. B.**—The Economic Value of Parasites and Predaceous Insects, Insect Life, vol 6, No. 2, pp. 142-146. Washington.

1908. **Snyder, H.**—Soils and Fertilizers. New York.

1906. **Sorauer, P.**—Handbuch der Pflanzenkrankheiten, Dritt Band, Bog. 1-5. Berlin.

1884. **South, R.**—Synonymic List of British Lepidoptera. London.

1848. **Scholtz.**—Uber den Aufenthalt der Dipteren während ihrer ersten Stände. Zeit. für Ent. Breslau.

1911. **Tansley, A. G.**—Types of British Vegetation. Cambridge.

1879-80. **Taschenberg, E. L.**—Praktische Insektenkunde. Bremen.

1892. **Theobald, F. V.**—An Account of British Flies, vol. 1. London.

1903-12. ——— Reports on Economic Zoology.

1909. ——— Insect Pests of Fruit. London.

1910. ——— Springtails (Collembolla); their Economic Importance, with Notes on some Unrecorded Instances of Damage. Rep. Econ. Zool., pp. 111-127.

1901-1909. **Verrall, G. H.**—British Flies. London. 2 vols. (1901 and 1909).

1901. ——— A List of British Diptera. Cambridge.

1851-56. **Walker, Fr.**—Insecta Brittanica. 2 vols.

1900. **Warrington, R.**—Lectures on some of the Physical Properties of Soil. Oxford.

1903. **Webster, F. M.**—Notes upon the Food of Predaceous Beetle. Bull. Ill. St. Lab. Nat. Hist., vol. 1, no. 3, pp. 167-176 (2nd edition).

1849-40. **Westwood, J. O.**—Modern Classification of Insects. Berlin.

1906. **Wingate, W. J.**—Durham Diptera. London. 2 vols.

Journals of the Board of Agriculture and Fisheries.

Leaflets of the Board of Agriculture and Fisheries.

EXPLANATION OF PLATES I AND II.

Illustrating Mr. Alfred E. Cameron's paper on a "General Survey of the Insect Fauna of the Soil."

Fig. 1. Pupa of *Dilophus febrilis*. Lateral view. × 12.8.

Fig. 2. Puparium of *Phytomyza affinis*. Dorsal aspect. *at. sp.*, anterior stigma; *pt. sp.*, posterior stigma. × 25.

Fig. 3. Larva of *Anthomyia radicum,* slightly dorso-lateral in position; *tb.*, caudal tubercles, of which there are seven pairs; *sp.*, anterior spiracle of the right side. × 15.

Fig. 4. Larva of Muscid type; roots of grass. *at. sp.*, anterior stigma; *pt. sp.*, posterior stigmata. × 20.

Fig. 5. Last abdominal segment, posterior end to show the posterior stigmata, *st.* × 40.

Fig. 6. Larva of *Dolichopus aeneus,* lateral view. In sandy loam, *tr.*, main tracheal trunks. × 25.

Fig. 7. Larva of Thereva. In sandy soil. Dorsal aspect; *l,* oberlippe; *o,* oberkiefer; *t,* kiefertaster; *kp,* kieferkapsel; *Z. gr.*, Zopfgraten; *st.*, stigma. × 10.

Fig. 8. Pupa of *Leptis scolopacea; st.*, spiracles.

Fig. 9. Larva of *Microchrysa polita.* Dorsal aspect. Showing arrangement of hairs (chaetotaxy). *sp.c.*, stigmatic aperture. × 13.

Fig. 10. Larva of *Bolitophila cinerea.* Lateral aspect; *sp.*, spiracles; *h.c.*, head capsule; *ant.*, antenna. × 17.

Fig. 11. Pupa of *Bolitophila cinerea.* Ventral aspect. × 13.

Fig. 12. Pupa of *Dolichopus aeneus.* Lateral view. *sp.* spiracles; *a.st.h.*, anterior stigmatic horns; *st.*, abdominal spiracles. × 15.

Fig. 13. Puparium of Dipterous insect species (6.3.12). × 15.

Fig. 14-15. Two species of Dipterous larvae (*Brachyeera*). In both lateral view; at roots of grass in both sandy and clay loam; outline sketch to show segmentation and ambulacral areas (*a*). That represented in Fig. 14 has the tween-segments (*t.s.*) characteristic of the larvae of Leptidae. Fig. 14, × 15; Fig. 15, × $12\frac{1}{3}$.

Fig. 16. Larva of *Hyctodesia incanis* (Anthomyiidae). Dorsal aspect; roots of grass in clayey loam; *pt. sp.*, posterior spiracles; *at. sp.*, anterior stigma. × 13.

Fig. 17. Larva of *Dalophus febrilis.* Lateral view; *st.*, spiracles, one in prothoracic segment immediately behind the chitinised head, and 9 abdominal spiracles. × 17.

Fig. 18. Larva of *Rhyphus fenestralis* (Diptera). Lateral aspect; *ch.*, chitinised head; *t.pr.*, terminal processes of last abdominal segment. × 18.

Fig. 19. Four anterior segments of larva of *Leptis scolopacea* (Diptera), showing anbulacral areas (*a*). × 19.

Fig. 20. Head of *Leptis scolopacea* (Diptera), showing mouth appendages. Dorsal aspect; *l,* oberlippe; *f,* fuhler; *o,* oberkiefer; *t,* kiefertaster; *u,* unterkiefer. × 30.

Fig. 21. Last two abdominal segments slightly ventro-lateral to show the 4 terminal processes; ventral to the 2 dorsal of these processes lie the 2 posterior spiracles. × 5.

Fig. 22. Larva of Diptera (Brachycera), at roots of groundsel (*Senecio jacobaea*); *t.p.*, terminal processes. × 10.

Fig. 23. Mouth parts of same in profile; *md.*, mandibles; *h.s.*, hypostomal sclerite; *c.p.s.*, cephalo-pharyngeal sclerite, forked distally; *v.s.*, ventral unattached sclerite, fish-bone like.

Fig. 24. Terminal segment of same to show stigmata (*st.*), and the five surrounding processes (*pr*). × 35.

Fig. 25. Larva of *Otiorhynchus sulcatus* (Rhyncophora). Lateral aspect; *pr.t.*, prothorax chitinised dorsally. × 10.

Fig. 26. Larva of *Exomias araneiformis* (Rhyncophora). × 4.

Fig. 27. Pupa of same. × 17.

Fig. 28. Larva of *Telephorus darwinianus* (Telephoridae). × 5.

Fig. 29. Pupa of same. × 10.

Fig. 30. Pupa of *Dolems gonager* (Tenthredinidae). × 8.

REVIEWS.

Bastin, Harold.—Insects, their Life-histories and Habits. Pp. xii + 349, 46 plts. London: T. C. and E. C. Jack, 1913. Price, 7s. 6d. net.

The object of this work is to present to the general reader a general outline of the salient principles of insect life, as illustrated by the origin, metamorphosis, classification, life-history, habits, etc., of the different orders. The subject matter has been carefully written, and throughout is most interesting, although the author seems to have restricted himself to a very limited number of workers, facts from whose investigations have materially added to the value of his book. Thus Reaumur, Westwood, Miall, and Riley, are each referred to only once, whilst Swammerdam, Kirkby and Spence, and a host of modern writers, find no mention. This is unfortunate, as very many points only casually referred to might have been illustrated by actual verified facts, and the quotations from the few writers consulted might profitably have been curtailed.

In many of the life-histories, it is unfortunate that the account given should be incomplete; the complete life-cycle is desirable, even had fewer cases been given. Apart from these matters the author has succeeded in producing a very readable book, which will no doubt attract a large circle of readers.

The work is illustrated by forty-six plates, which surpass in excellence anything we have seen in similar works, and they reflect the highest credit on all concerned in their production.

Haas, Paul, and T. G. Hill.—An Introduction to the Chemistry of Plant Products. Pp. xii + 401. London: Longmans, Green and Co., 1913. Price, 7s. 6d. net.

A good working knowledge of chemistry is essential to the botanist, but not infrequently we find that the student "is deficient in just those branches of chemistry which are of particular importance to the botanist, which is, no doubt, largely due to the fact that those compounds which are of interest to the botanist do not necessarily fit into the scheme of instruction of the chemist."

The authors of the present work have attempted to provide such students with an introductory account of the chemistry and biological significance of some of the more important substances occurring in plants, the uses of such plant products, and the manufacturing processes employed in their preparation. The result is a very carefully compiled work, well put together, and one that must find a place in every botanical

laboratory and on the shelf of all students and teachers. Apart from this side, it will be found to be of great value in many trades as a concise and lucid work of reference.

Herms, W. B.—A Laboratory Guide to the Study of Parasitology. Pp. xv + 72. New York: The Macmillan Co., 1913. Price, 3s. 6d.

The fact that the various exercises here set forth have been used by the author for the past four years, and have had careful testing in the laboratory, strongly recommends them to students and teachers elsewhere.

The Guide is divided into three parts, the first entitled medical entomology, the second helminthology, and the third life-history studies on living parasites.

Although the details given under the different headings are brief, they are thoroughly practical, and will no doubt serve as a basis in many institutions where so important a branch of biological work as parasitology is now being taught.

Horwood, A. R.—A Hand-List of the Lichens of Great Britain and the Channel Islands. Pp. 45. London: Dulau and Co., Ltd. [1913]. Price, 1s. net.

This List will, of course, be of great use to all collectors of Lichens, and has been long desired. It is absolutely necessary for collectors to have such a list at hand as a guide to the arrangement of the herbarium, as without it the latter loses a large part of its value for ready reference. All text-books get, sooner or later, out of date, but a list can be frequently republished so as to include the most recent additions.

But there is one mistake which is frequently made by the composers of such a work: a *list* is not the proper place for introducing extensive changes of nomenclature. Such alterations merely render it cumbrous if synonyms are inserted, or useless to a certain extent if they are not. We are sorry that Mr. Horwood has followed, even though only in a small degree, the bad examples set in that respect by recent transatlantic compilers. The portion which closely follows Part II of the "British Lichens," by Miss A. L. Smith, F.L.S. (recently published by the British Museum), offers little ground for complaint, but only that portion which refers to species not included in that volume.

The most unfortunate innovation has been the adoption of the name *Xanthoria* to include all the species of *Physcia*; even if the laws of priority demanded it (which they do not), it would be wrong to apply a name essentially denoting "yellowness" to a series of forms of which less than 25 per cent. are of that colour. The citations of "authorities" for the specific names in the list follow no settled plan, nor does the

adoption of sub-generic names; compare the sub-divisions of *Leptogium* on pp. 6 and 7 with those of *Lecidea* on pp. 25 *seqq.* Mr. Horwood seems to be in doubt about admitting the formerly so-called alga, *Botrydina vulgaris*, to be a Lichen, as it has been shown to be by Miss Acton, and places it on the same level as *Sirosiphon ocellatus*, Kutz., which is nevertheless an undoubted Alga and a member of the genus *Stigonema*. See West's British Freshwater Algae, p. 320.

W. B. G.

Morley, C.—A Revision of the Ichneumonidae based on the Collection in the British Museum (Natural History), with descriptions of new genera and species. Pt. I, pp. xi + 88, 1 plt. 1912. Price 4s. Part II, pp. xi + 140, 1 plt. Price 5s. 6d. Published by the Trustees of the British Museum.

The value of this work to students of the enormous Family Ichneumonidae can only be realised by those who are actively engaged upon the Family. Fortunately all the new genera and species here described are in our National Collection, and therefore easily accessible.

As in the author's previous work, the descriptions are full and clear, but we trust that before the series is completed a volume will be devoted to illustrations.

Quanjer, H. M.—Die Nekrose des Phloems der Kartoffelpflanze die Ursache der Blattrollkrankheit. Meded. L.-T.-en Boschbouwsch., 1913, D. vi, pp. 41-80, T. ii-ix.

The leaf-roll disease of potato, owing to its serious nature, has attracted many investigators. Some workers ascribe it to infection, but the majority of workers place it among the obscure "physiological" diseases. Several workers have associated the diseased condition with an alteration of enzyme content, and an excess of oxidases has been described in the affected plants. The disease is of special importance in Holland, so Dr. Quanjer has made a close study of it especially in "Paul Kruger" potatoes. He points out that in the attempt to relate internal changes to the symptoms of the disease attention has been paid only to the xylem, in spite of the fact that a red colouration of the leaves is one of the symptoms. Such a colouration suggests an interference with translocation from the leaves, caused possibly by some change in the phloem. This change the author found in affected plants of nearly 30 varieties. A transverse section shows that many of the phloem strands are in a collapsed condition, so that the walls and cavities of the individual sieve-tubes and companion cells cannot be distinguished. The shrunken elements are yellow in colour, and give the lignin reaction. The death of the elements is thus associated with a lignification of the walls, a phenomenon

which is very rare in the phloem of normal plants. It was found that the degeneration set in very early in young plants, as soon as the first few leaves had unfolded. The author points out that the smallness of the plant, the shortness of the stolons, and the small yield of tubers can all be associated with interference with the transport of protein and carbohydrate caused by a degeneration of the phloem. The red colouration of the leaves is also to be associated with an accumulation of assimilatory material in the leaf.

This discovery of the association of degeneration of the phloem with the disease in question points strangely to the "physiological" nature of the disease, but it throws no light on the nature of the obscure chemical and physical changes which must precede degeneration. The nature of the disease indicates the difficulty of treatment, but it is pointed out that external conditions apparently do play some part, for the variety "Paul Kruger" is much less liable to the disease in some parts of Holland than in others. The author believes, however, that the main factor in the incidence of the disease is an inherited tendency, which is exhibited far more markedly in some varieties than in others. Some of his experiments, not yet completed, indicate, however, that some forms of the variety "Paul Kruger" are more resistant than others, and that by careful selection one can produce an immune race. The completion of his experiments will be awaited with much interest.

V. H. B.

Ross, E. H.—The Reduction of Domestic Flies. Pp. viii + 103, 18 figs. London: John Murray. 1913. Price, 5s. net.

The importance of Dr. Ross' work it would be difficult to overestimate. Our public authorities are slow to grasp and assimilate the work of the scientific investigator, and on an important subject such as the dissemination of disease by flies, it is a case of first educating the public mind. Such a work as the one before us vividly brings home the danger and expense of neglect in this matter; it shows what other countries are doing in organising fly campaigns, the opposition to be expected, the justification of expenditure of money and energy, the education of children on the subject, and numerous other matters.

"Fly-reduction," the author states, "means a saving of life and therefore money. It reduces sickness, sorrow and misery. It results in a riddance of a pest. It entails a better sanitary inspection, the discovery of insanitary conditions and places. It improves our knowledge of certain diseases. Its cost is small."

Apart from the main object of the book, it is a most interesting volume, and we strongly recommend it to all interested.

THE

JOURNAL OF ECONOMIC BIOLOGY.

ON TWO NEW SPECIES OF THYSANOPTERA FROM THE WEST INDIES.

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WITH 2 FIGURES.

MR. FRANK BIRKINSHAW, of the Agricultural Experimental Station, Kingstown, St. Vincent, has recently been kind enough to send me two small collections of thrips which he had taken in the grounds of that station on Cacao and Bitter Cassava [*Mandiocca* (*Manihot*) *utilissima*.]. The collection from Cacao consisted entirely of larvae and adults of *Heliothrips rubrocincta* (Giard); that from the Cassava contained two species, both of which appear to be new, and are described below. One of these belongs to the genus *Frankliniella*, Karny, and approaches very near to *Fr. cephalica* (Crawford). For the other it has been found necessary to erect a new genus, which differs in several respects from the known genera of the Thripidae, s. str., but is best retained in this family in the present state of our knowledge of this group. Mr. Birkinshaw, in respect of the species of Cassava, writes: "The manihot leaves are injured somewhat, so, of course, do not develop properly; the pest, however, does not appear to be a source of very great injury, as far as the yield is concerned, unless it should be present in large numbers." When writing the above, Mr. Birkinshaw was unaware that two species were present, so I cannot say to which one in particular his remarks refer.

Fam. **Thripidae.**

Gen. **Corynothrips,** nov.

Head produced forward in front of the eyes. Antennae long and slender, apparently nine-segmented, owing to the presence of an oblique cross division in the sixth segment. Maxillary palps two-jointed; labial palps two-jointed, the basal joint very short and obscure. Two spines on each hind angle of the prothorax and one on each front angle. Legs long and slender. Wings very narrow

and curved forward at the tip. Fore vein of the front wing merged with the front margin; hind vein short and inconspicuous. Abdomen long and narrow. All the long spines on the wings and body minutely spinulose at tip.

Type, *Corynothrips stenopterus*, n. sp.

This genus may easily be distinguished from all known genera of Thripidae by the venation of the fore wing and by the spinulose tips to all the spines. It is further separated from all genera except *Ctenothrips*, Franklin, by the prolongation of the head in front of the eyes to form a "crown." From this genus and from all other genera except *Euthrips* (*Anaphothrips*) in part, it is separated by the oblique division of the sixth antennal joint.

Corynothrips stenopterus, n. sp.

(Fig. 1.)

Female. Measurements.—Head, length, 0.17 mm., width across eyes, 0.138 mm.; prothorax, length, 0.138 mm., width, 0.189 mm.; pterothorax, length, 0.247 mm., width, 0.247 mm.; abdomen, length about 0.84 mm., width, 0.218 mm.; wing, length (from tip of basal lobe), 0.653 mm., width, about half way along, 0.029 mm.

Antennae.—

Segment -	1	2	3	4	5	6	7	8
Length (μ) -	17.5	45	85	75	62.5	47.5 + 15	12.5	17.5.
Width (μ) -	27.5	27.5	20	16	12.5	12.5	5	4

Total body length about 1.4 mm.; antennae, 0.375 mm.

Colour.—Yellow with brown and red markings. The whole of the dorsal surface and the anterior part of the ventral surface of the head, brown; the dorsal surface of the prothorax irregularly but nearly symmetrically marked with red brown. A dorsal red brown blotch on abdominal segments 3, 4, 6, 7 and 8, that on segment 6 being faint and small, the others larger. The last two abdominal segments brown. The mouth-cone, pterothorax, legs and rest of the abdomen yellow.

Head (Fig. 1*a*) longer than broad, produced between the eyes into a blunt prominence on which the antennae are placed, cheeks slightly arched, back of the head slightly striated. Eyes large, black, and very protruding. Ocelli present, very close together, the two posterior red (probably due to the presence of red pigment beneath), the anterior in a line with the front of the eyes, colourless and facing forward. Crescents indistinct. A very long hair just anterior and dorsal to each posterior ocellus, a very short hair at each side of the anterior ocellus and a few other short ones behind each eye. Mouth-

cone long and rather blunt, reaching across the prosternum. Maxillary palps two-segmented, the second segment about six times as long as the first, with three sensory bristles at the tip, and three others lower down (Fig. 1*c*). Labial palps two-segmented, the basal segment very short and indistinctly separated from the labium, the apical segment long and slightly curved with three sensory bristles at the tip (Fig. 1*d*). Antenna (Fig. 1*b*) apparently nine-segmented,

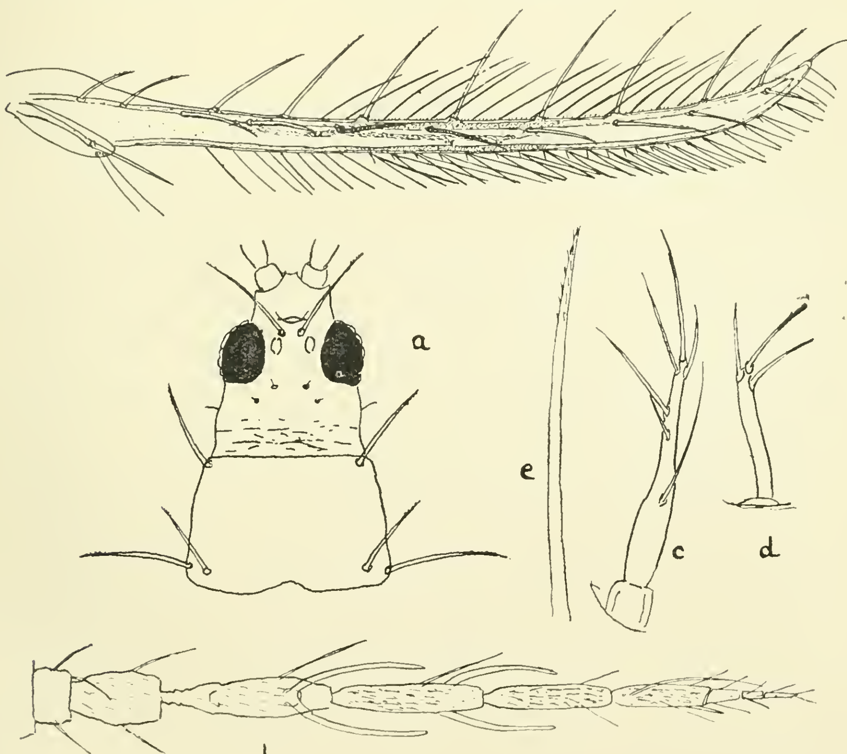

Fig. 1.—*Corynothrips stenopterus*, n.sp.

a, head and prothorax ; *b*, antenna (from above) ; *c*, maxillary palp ; *d*, labial palp ; *e*, spinulose seta ; *f*, wing (posterior fringe not completed).

owing to the presence of a slightly oblique division in the sixth segment ; long and slender, over twice the length of the head. The first segment short and cylindrical ; the second longer and barrel-shaped ; the third long and thin, irregularly narrowed to a short pedicel at the base ; the fourth and fifth long and narrow, slightly constricted at the base ; the sixth slightly narrowing beyond the cross division ; the eighth slightly longer than the seventh. All the seg-

ments are covered with minute hairs. The apical segments have longer hairs also, one at the base of the sixth segment being particularly noticeable. A very long forked trichome on the dorsal side of the third segment, and a similar one on the ventral side of the fourth. The first and second segments are brown; the third red brown to the base of the trichome; the fourth clear to the base of the trichome, then slightly darker; the fifth clear, slightly darker at the tip; the sixth, seventh and eighth clear.

Prothorax irregularly marked with red brown, shorter than the head, gradually widening behind. One long, slender bristle at each front angle, and two at each hind angle, one slightly more dorsal and shorter than the other. These long spines, and also the two on the head between the ocelli have a double row of minute spines on one side towards the end (Fig. I*e*). The hind margin of the pronotum is slightly indented in the dorsal middle line. Pterothorax large, front angles rounded, gradually narrowing behind. Legs very long and slender, all tibiae slightly widened distally. Fore tarsi unarmed, hind tibiae with only very weak spines. There is a dark spot at the base of the second tarsal joint in each leg. Wings very long and narrow, strongly curved forwards at the tip. Fore wings (Fig. I*f*) clear, except for the middle third, which is darker with both margins, and for a short distance a median line, red brown. The fore vein is, except at the very base, apparently merged with the costal vein, the two forming a broad anterior margin somewhat similar to that in *Panchaetothrips*, Bagnall. There are nine spines on the costal vein, two on the basal part of the fore vein, and eight on the part of the vein fused with the costa. The first two spines in the dark area on the fore vein are also dark. A little before the dark area in the middle of the wing the merged costal and fore vein gives off a very indistinct posterior branch which runs along the middle of the wing, becoming red brown and conspicuous as it crosses the dark area, and disappearing either at or a little beyond the third spine on the fore vein after the fork. This branch appears to fuse partially with the fore vein at the first and third spines after the fork, the first of these spines being between the fore vein and the branch. The costal vein is continued round the tip of the wing along the hind margin as far as the tip of the basal lobe. The basal lobe is indistinctly separated from the rest of the wing, and bears one spine on the dorsal side and two finer wing-retaining spines on the ventral side. All the spines on the wing are spinulose at the tip. The fringe on the posterior margin is very long. Hind wings clear, curved forwards at the tip. The single vein is distinct almost to the tip of the

wing and is dark, conspicuous, and minutely sinuate. There are two short spines in the middle of the wing near the base, and two longer ones on the lobe.

Abdomen rather long and narrow, with only very short hairs, except on the last two segments. On these there are several long hairs, which are also spinulose at the tip.

Described from about thirty females found on Cassava plants (*Mandiocca utilissima*) in the Agricultural Experimental Station, Kingstown, St. Vincent, West Indies, by Mr. F. Birkinshaw, in October, 1912.

Type in the Hope Department, Oxford University Museums.

Egg.—In one of the specimens an egg is visible in the abdomen. It is elongate kidney-shaped, about 0.25 mm. long by 0.06 mm. broad. It is situated longitudinally, and reaches from the middle of the third segment to the hind margin of the fifth.

Frankliniella melanommatus,[1] n. sp

(Fig. 2).

Female. Measurements.—Head, length, 0.112 mm., width, 0.150 mm.; prothorax, length, 0.125 mm., width, 0.185 mm.; pterothorax, length, 0.22 mm., width, 0.25 mm.; abdomen, width, 0.25 mm., length, about 0.58 mm.; wing, length (from tip of basal lobe), 0.55 mm., width, about half way along, 0.045 mm.

Antennae.—

Segment	-	1	2	3	4	5	6	7	8
Length (μ)	-	20	35	55	50	37.5	45	7.5	10
Width (μ)	-	27.5	25	22.5	20	17.5	15	7.5	5

Total body length, 1.1 mm.; antennae, 0.27 mm.

Colour.—Yellow, apical segments of the antennae a little darker. Eyes, dark red-brown.

Head (Fig. 2*a*) broader than long, rectangular, slightly retracted into the prothorax; cheeks parallel; back of the head not striated. The only conspicuous spines are one behind each eye [2] and one just in front of each posterior ocellus. Eyes large, dark, not protruding. Ocelli present, the two posterior on a level with the back of the eyes, the anterior one slightly directed forwards into a depression on the front part of the head. Crescents distinct, dark yellow. Mouth-cone reaching almost across the prosternum. Maxillary palps three-segmented, the third segment the longest. Labial palps two-segmented, the basal segment very short. Antennae (Fig. 2*b*) more than twice

[1] μελανομματος = with dark eyes.

[2] This has been omitted by accident in Fig. 2*a*.

the length of the head, the first segment short, cylindrical; the second produced dorsally into a blunt tubercle bearing two stout dark spines (Fig. 2*c*); the third with a dorsal forked trichome and, below the base of this, two dark spines not quite as stout as those on the second segment; the fourth with a ventral forked trichome; the eighth longer and narrower than the seventh. Colour: the first segment clear, the second and third tinged with grey at the apex, the fourth tinged with grey in the apical third, the fifth clear, the sixth, seventh and eighth grey.

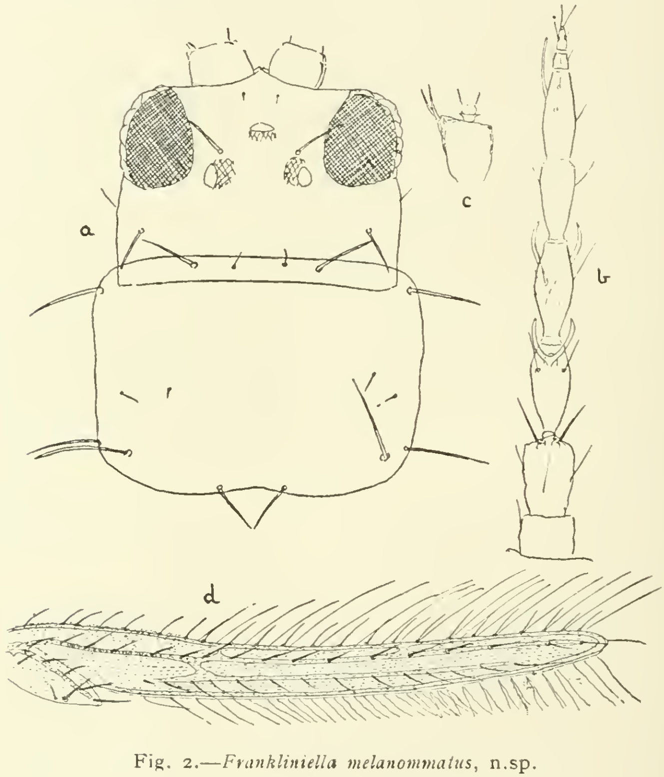

Fig. 2.—*Frankliniella melanommatus*, n.sp.
a, head and prothorax; *b*, antenna (from above); *c*, lateral view of second antennal segment; *d*, wing.

Prothorax wider than long, and slightly longer and wider than the head; its hind angles rounded. Two long spines at each hind angle, and one on each front angle, two slightly shorter on the anterior margin, and two shorter again on the hind margin. Pterothorax large, front angles rounded, two long spines in the middle between the wings. Legs with numerous short hairs, posterior tibiae with two stout spines at the apex. Wings reaching to

about the eighth abdominal segment, the marginal vein and two longitudinal veins distinct in the fore wing (Fig. 2*d*). The posterior vein arises at about one quarter of the wing's length from the base, and reaches nearly to the tip of the wing. It has in its length usually twelve or thirteen spines (varying from ten to fifteen in the specimens examined), and is connected at about the level of the second spine to the front vein by a branch from the latter. There are seventeen to twenty spines on the fore vein, and twenty-two to twenty-six on the costa. There is also a distinct vein with five spines on it on the basal lobe. Hind wings clear, vein indistinct, but distinguishable almost to the apex, the minute hairs with which the whole wing is covered being darker along its length.

Abdomen normal; a single distinct posterior-lateral spine on the segments 1-7, two on segment 8, eight long spines on the ninth segment, and four long and two shorter on the tenth segment.

Male smaller than the female (about 0.80 mm.). Abdomen rounded at the tip, with a pair of long spines on the posterior-lateral margin of the ninth segment, each on a slight tubercle, and a similar pair on the tenth segment. The testicles are yellow. The number of spines on the hind vein of the fore wing is less variable than in the female, being almost always twelve (once eleven and once thirteen out of about sixteen counts).

Described from four females and about a dozen males collected on Cassava (*Mandiocca utilissima*) in the Agricultural Experimental Station, Kingstown, St. Vincent, West Indies, by Mr. F. Birkinshaw, in October, 1912.

Type in the Hope Department, Oxford University Museums.

This species comes very near to *Frankliniella cephalica* (Crawford),[1] which it resembles in the shape of the head, the structure of the second antennal joint, and the colour. It can be separated from that species, however, by the following points, which, I think, justify it ranking as a distinct species.

A. Eyes yellow, 8th antennal joint shorter than the 7th, a single trichome on the 3rd joint, 17 spines on the hind vein, front ocellus directed straight forward.

. . . *F. cephalica* (Crawford). Mexico.

AA. Eyes dark, 8th antennal joint longer than the 7th, forked trichome on the 3rd antennal joint, about 12 (10-15) spines on the hind vein, front ocellus only slightly directed forward.

. . . *F. melanommatus*, n. sp. W. Indies.

[1] Both of these species are readily separated from the recently described *Stylosa*, Hood, by the colour.

RECORDS AND DESCRIPTIONS OF BRITISH THYSANOPTERA.

BY

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WITH 3 FIGURES.

DURING the past two years I have been able to give a certain amount of time to the collection and study of the Thysanoptera, and herein I record some observations on the more interesting species, descriptions of *Rhipidothrips brunneus, Euthrips badius, Bagnallia variabilis, Bagnallia asemus*, spp. nov., and further record *Cryptothrips major*, Bagnall, as new to the British Fauna.

I have found the method of collecting flowers in paper bags, recommended by Uzel, to be of great value, as it is possible to get material by post from various parts of the country from correspondents who know nothing of entomology. Thus I have already in this way received specimens of the Pea thrips, *Frankliniella robusta* (Uzel) from about twenty-four counties in England, Wales and Ireland.

I have deposited types of all the new species described below in the Hope Department of the Oxford University Museums.

Order THYSANOPTERA.

Sub-order TEREBRANTIA.

Family **Aeolothripidae.**

Aeolothrips albocinctus, Hal.

One apterous female at Wicken Fen, Cambridge, on July 27th, 1913.

Rhipidothrips brunneus, n. sp.

Female (Forma Brachyptera).

Measurements.—Head, length, 0.190 mm., width, 0.190 mm.; prothorax, length, 0.160 mm., width, 0.210 mm.; pterothorax, length, 0.25 mm., width, 0.24 mm.; abdomen, width, 0.41 mm.; wing, length about 0.16 mm.

Antennae.—

Segment	-	1	2	3	4	5	6	7	8	9
Length (μ)	-	20	36	68	60	56	41	36	16	12
Width (μ)	-	40	30	24	24	26	24	20	14	8

Total body length about 1.62 mm.; antennae, 0.36 mm.

Colour, dark brown, with the third and fourth antennal segments, the tarsi, and the apical parts of the tibiae lighter.

Head as long as wide. Cheeks slightly arched, bearing four or five short, stout, forwardly directed spines in their anterior half just behind the eyes. Two small setae in front of the anterior ocellus, and two on each side of it near the margin of the eye; a longer seta between the anterior and each posterior ocellus. Several smaller hairs scattered over the posterior dorsal part of the head. Eyes dark, not prominent. Ocelli small, placed at the corners of a nearly equilateral triangle; the two posterior close to the margins of the eyes, the anterior one directed slightly forward. Crescents not apparent. The mouth-cone reaching two-thirds across the prosternum. The maxillary palpi three-jointed, with the last segment very short. The labial palpi cannot be made out in the specimen, but doubtless conform with the generic type in being four-jointed. The antennae are almost twice as long as the head; the first segment short and stout, the second barrel-shaped, the third long and with a distinct pedicel, the fourth slightly shorter than the third, the fifth, sixth and seventh are rather broadly articulated, while the seventh, eighth and ninth form a more or less complete whole. The seventh segment is longer than the eighth and ninth together. A single sense cone near the distal end of the fifth segment ventrally, and another similarly situated on the sixth segment. Colour: first and second segments dark brown, third and fourth much lighter, fifth to ninth darker, but not so dark as the first two. The anterior margin of the first segment bears dorsally and ventrally a small projection.

Prothorax shorter but wider than the head, its hind angles square. A very short, stout, curved spine at each front angle. A long spine just anterior to each hind angle and a small curved one at the hind angle. Two pairs of comparatively stout spines on the hind margin, each pair being close together. Pterothorax broader than the prothorax, but not very stout. Legs dark, with the outer half of the tibiae and all the tarsi a little lighter. Wings reduced to small white pads, not reaching beyond the hind margin of the pterothorax.

Abdomen stout, no long spines except on the last two segments, where they are pale brown in colour, but not so light as those of *R. gratiosa*, Uzel.

Described from a single brachypterous female beaten from grass on May 25th, 1913, on the coast at Bognor, Sussex, England.

Type placed in the Hope Department, Oxford University Museum.

The three known species of the genus *Rhipidothrips* can be easily separated as follows:—

I. Without spines at the hind angles of the prothorax.
. . . . . *R. niveipennis*, Reuter. Finland.

II. With a long spine at (or near) the hind angle of the prothorax.

(*a*) Second antennal segment light. Prothorax light with dark central markings, all femora light at the apex and base. Six or eight more or less regularly placed, light coloured spines along the hind margin of the prothorax.
. . . . *R. gratiosa*, Uzel. Bohemia, England.

(*b*) Second antennal segment dark. Prothorax and femora uniformly brown as the rest of the body. Two pairs of spines on the hind margin of the prothorax.
. . . . *R. brunneus*, n. sp. England.

R. brunneus may be further distinguished from *R. niveipennis* by the colour of the tibiae, by the fifth antennal segment being dark (light in *niveipennis*), also the seventh segment of the antenna in *brunneus* is longer than the eighth and ninth together, whereas Reuter[1] figures the seventh, eighth and ninth as more or less equal in length in *niveipennis*. It also differs from *R. gratiosa* in the arrangement of the small setae round the ocelli, and in having fewer small setae on the posterior dorsal surface of the head. My British specimens of *R. gratiosa* have a sharply marked off area at the back of the head, where the striations of the surface is much more distinct; this area is also present in *brunneus*, but is not so well marked. Further, my specimens of *R. gratiosa* have a row of short, stout spines behind each eye, not mentioned in Uzel's description of the species, resembling those described above in *brunneus*, but differing slightly in number and arrangement.

Melanothrips fuscus (Sulz.).

Not uncommon in various flowers. A plant of *Sinapis arvensis* on the University Farm, Cambridge, was swarming with this species on the 25th May, 1911, nearly all the specimens being males. Later in the year only females were taken.

Family Thripidae.

Chirothrips manicatus, Hal.

The only forms of this species that I have taken are the macropterous female and the apterous male, both of which are not uncom-

[1] Acta Soc. Fauna. Flora Fennica, 1899, xvii., No. 2, p. 30.

mon in grasses and sedges. For the same day (12/9/11) I have the two following records, which show an interesting contrast:—"Wimbledon, Surrey, on *Molinia*, males abundant, including some var. *adusta*, Uzel, one female"; "Horning, Norfolk, on *Typha* and *Phragmites*, 42 females, no males (per G. Storey)." I have found the winged females hibernating in sedge stacks at Wicken Fen.

Limothrips cerealum, Hal.

Common in both sexes and widely distributed. Females hibernating under bark and in sedge stacks, September to April.

Limothrips denticornis, Hal.

I have not found this so abundant as the preceding, but both sexes were common on Barley at Wicken in July. Also females hibernating in the sedge stacks during the winter.

Sericothrips staphylinus, Hal.

Brachypterous males and females not uncommon in *Ulex europaeus* in the New Forest, September, 1911. Macropterous females among grass near Oxford, July, 1913.

Frankliniella tenuicornis (Uzel).

I have taken a single female of this species on oats at Wicken Fen, Cambridgeshire, on July 27th, 1913.

Frankliniella robusta (Uzel).

This species, described by Uzel in 1895 (Monog. dei Thysanoptera, p. 104) as *Physopus robusta* is the same as that described by Westwood as *Thrips pisivora* in 1880 (Gardeners' Chronicle, 2nd series, vol. xiv, p. 206), but as the latter described only the larva, which he found damaging peas, Uzel's name must take precedence. Uzel's genus *Physopus* having since been split up the name now stands as above.

This species is often very injurious to peas and beans in this country. I have succeeded in following through its complete life-history, and although intending to write a more complete account at some future date, I give here the following short summary, it seeming unnecessary to delay the publication of facts of economic importance while several small points of purely scientific interest are settled.

Adults are to be found from the middle of May to the end of July. The males only occur during the first part of that time. The eggs are laid, as discovered by Warburton (Journ. Roy. Agric. Soc.,

England, 1898, vol. lxix, p. 321) chiefly in the stamen sheath of peas (*Pisum satua*) or beans (*Vicia faba*), and hatch after about eight days. The larva, orange-yellow with a black tail, is full-fed in about sixteen to twenty days, when it descends into the soil. There it remains throughout the rest of the summer, autumn and winter till the following May, when it passes through its two pupal stages and emerges as the perfect insect at the end of May or during June.

Physothrips pyri (Daniel).

I have taken this species, so injurious in America, on apple at Histon, near Cambridge, in 1911, and have had specimens sent to me from Cambridge this year. I also received larvae which I believe to belong to this species from Cirencester. There is no doubt that it has been with us for many years, and must occur in many other localities, either not common enough to do any damage, or else having the damage it does attributed to some other pest.

Oxythrips ajugae, Uzel.

This species occurs in abundance in the pines, especially those bearing male cones, at Oxshott, Surrey, in the spring. I have also taken hibernating adults of both sexes from pine stumps in the winter by means of the Berlese Funnel. I do not yet know what happens to it during the rest of the year.

Euthrips (Anaphothrips) obscurus (Mull.).

A single macropterous female on *Spartina*, Hamble Creek, Hampshire on September 5th, 1911.

Euthrips orchidaceus (Bagnall).

I found this species not uncommon in the Liverpool Botanic Gardens on various orchids, *e.g.*, *Cypripedium*, *Epidendron*, *Miltonia*, *Oncidium*, *Mormodes*, *Odontoglossom*. The male, of which I took four specimens, has only been mentioned by Mr. Bagnall,[1] and has not yet been described.

Male smaller than the female (about 1 mm.), general colour pattern similar, but without the brown dorsal patches on the second to seventh abdominal segments. The first two antennal joints are light-coloured. The orange-coloured testes distinctly visible. On the dorsal side of the ninth abdominal segment are two pairs of short, stout spines, one pair on the extreme posterior margin, and the other just anterior to these, and very slightly longer.

[1] Ent. Mon. Mag., 1909, vol. xx, p. 34.

Euthrips badius, n. sp.

(Fig. 1).

Female. Measurements.—Head, length, 0.128 mm., width, 0.158 mm.; prothorax, length, 0.128 mm., width, 0.208 mm.; pterothorax, length, 0.280 mm., width, 0.274 mm.; abdomen, width, 0.307 mm.; wings, length (from tip of wing to tip of basal lobe), 0.726 mm., width (about half-way along), 0.065 mm.

Antennae.—

Segment	-	1	2	3	4	5	6	7	8
Length (μ)	-	8	31	39	37	37	35+10	7	10
Width (μ)	-	28	28	19	18	18	18	6	4

Total body length, about 1.25 mm.; antennae, 0.228 mm.

Colour, dark brown. Tarsi and ends of tibiae slightly lighter. Head (Fig. 1*a*.) wider than long, rounded in front. Sides slightly diverging posteriorly, cheeks very slightly arched, back of head faintly striated. Only short hairs on the upper surface; four in a transverse row in front of the ocelli; one in front of, and one behind each posterior ocellus, and two behind each eye. Eyes black, not protruding. Ocelli distinct, forming an almost equilateral triangle. Crescents red brown, distinct, broadest on posterior ocelli. Mouth cone fairly large, reaching three-quarters across the prosternum. Maxillary palpi three-jointed, third joint longest, middle shortest (Fig 1*b*.). Labial palpi two-jointed, basal joint short and stout, with three sensory hairs at the tip of the second joint (Fig. 1*c*.).

Antennae apparently nine-segmented, owing to the presence of a slightly oblique cross division in the sixth segment; not quite twice as long as the head. Colour, dark brown, second, third and base of fourth segment slightly lighter. First segment very short and thick, second large and almost spherical, third distinctly longer than second, fourth and fifth only slightly shorter than the third. Cross division in the sixth segment about one-fifth of its length from the anterior end. Forked trichomes on the dorsal side of the third segment, and on the ventral side of the fourth segment (Fig. 1*d*.).

Prothorax as long as the head, and distinctly wider, hind angles rounded. Four or five small spines along its hind edge on each side. No long spines on the hind angle. Mesothorax largest, with front angles rounded. Metathorax gradually constricted behind. Legs dark, with the tarsi and ends of the tibiae slightly lighter. Fore and mid tibiae without conspicuous spines, hind tibiae with two distinct spines at the end, and a row of six or seven along the inner margin. Six spines on the hind tarsus, two in continuation of

the row on the tibia, two dorsally near the base of the tarsus, and two dorsally at the tip projecting over the second joint.

Wings fully developed, reaching to the posterior margin of the eighth abdominal segment. Fore wings (Fig. 1*e*.) strongly clouded with a small round clearer spot between the two veins near the base, just beyond the joint of the lobe, about one-fifth of the width of the

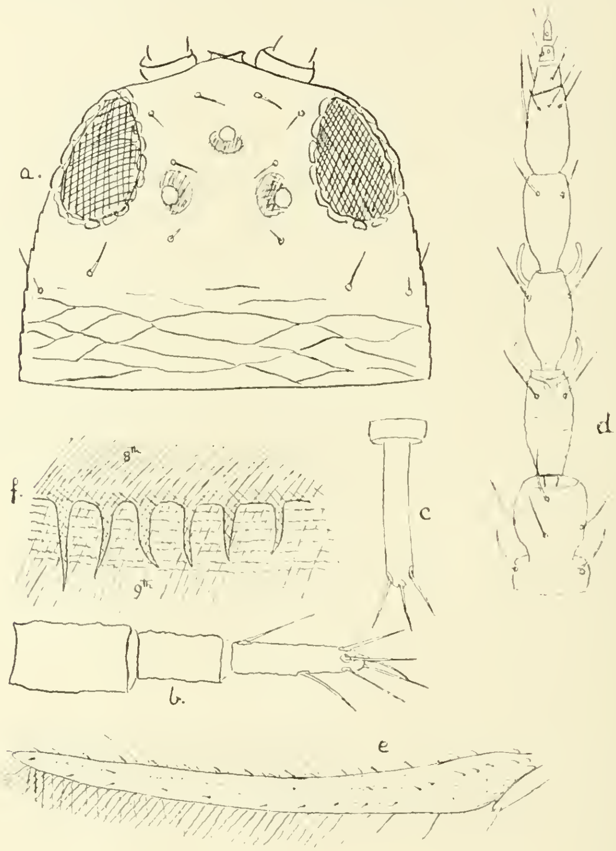

Fig. 1.—*Euthrips badius*, n.sp.
a, head; *b*, maxillary palp; *c*, labial palp; *d*, antenna; *e*, wing; *f*, portion of "comb" on hind margin of 8 abdominal tergite.

wing at that point in diameter. Veins indistinct, seven to ten spines on the hind vein, the distal ones further separated than the proximal. On the fore vein seven to nine spines at the base, then a short space, then either one or two, then another space, then two more. All the spines on the wing are short. Hind wings almost transparent,

slightly clouded at the very base, the single vein distinct almost to the tip of the wing.

Abdomen stout, rapidly contracted in the eight and ninth segments. The tenth segment half again as long as wide at the base. A comb-like arrangement of short spines of the hind margin of the eight tergite, with transverse striae beneath on the ninth segment (Fig. 1*f*.). Spines on the ninth segment slightly longer than the tenth segment, spines on the tenth segment shorter.

Male about one-fifth smaller than the female, and slightly paler in colour, more particularly the wings. Two pairs of short, stout spines on the dorsal posterior region of the ninth abdominal segment, the anterior pair being slightly stouter and closer together. There are small, thinly chitinised areas on the second to ninth abdominal sternites shaped as follows:—On the second sternite oval with the posterior margin a little indented; on the third kidney-shaped; on the fourth the indentation of the hind margin almost divides the area into two; on the fifth a plain oval; on the sixth sternite a small circular area. Otherwise the male is similar to the female.

Described from specimens obtained at Wicken Fen, Cambridgeshire, England, as follows:—Three females found hibernating in a stack of cut sedge (*Carex*), on March 11th, 1912, another female taken in a similar situation on the 20th April, 1913, and about sixteen females and two males beaten from grass and sedge on July 27th, 1913. It is noticeable that all the specimens taken on the latter date are a little smaller and paler than those taken in the winter, suggesting a possibility of slight seasonal variation.

Types of both sexes placed in the Hope Department, Oxford University Museums.

The species *obscurus*, (Mull.), and *secticornis* (Trybom), are the only other members of the genus *Euthrips* which have the sixth antennal joint divided, and from these the above species may be separated as follows:—

I. Second antennal joint sub-spherical, much broader and shorter than the succeeding three joints.

(*a*) Colour light; first antennal joint clear; head about as wide as long, slightly square in front with the eyes a little protruding; two or three spines on the outer half of the fore-vein.

. . . . *obscurus* (Mull.). (*striatus*, Osborne). Europe. N. America.

(*b*) Colour dark brown; antennae, including the first segment, dark; head wider than long, rounded in front; eyes not protruding; three or four spines on the outer half of the fore-vein.

. . . . *badius*, n. sp. England.

II. Second, third, fourth and fifth antennal joints all of the same length and width.

. . . . *secticornis* (Trybom). N. America.

Aptinothrips rufus, Hal.

This abundant grass-inhabiting species is interesting both from the scarcity of its males and from the fact that two forms are known, differing in the number of the joints in the antennae. The commonest form in this country has the antennae six-jointed (v. *connaticornis*) while a scarcer and more local variety has the antennae with eight joints, the last three being equivalent to the sixth joint in var. *connaticornis*. The two forms do not usually occur together, and out of very many records for this species I have only twice taken both forms together at one place. During this last September (1913) I have taken about twenty males of this species among many hundreds of females. The males do not seem to occur at any other time of the year.

Bagnallia asemus,[1] n. sp.

(Fig. 2).

Female (*Forma Brachyptera*).

Measurements.—Head, length, 0.11 mm., width, 0.11 mm.; prothorax, length, 0.11 mm., width, 0.153 mm.; pterothorax, length, 0.226 mm., width, 0.2 mm.; abdomen, width, 0.253 mm.; wing, length (from tip of wing to tip of basal lobe), 0.125 mm.

Antennae.—

Segment	-	1	2	3	4	5	6	7
Length (μ)	-	25	33	37.5	36	36	44	14
Width (μ)	-	25	22	19	19	16.5	19	8 5

Total body length about 1.3 mm.; antennae, 0.233 mm.

Colour, greyish-brown, with a tinge of yellow. Tarsi and ends of tibiae slightly lighter.

Head about as wide as long, sides slightly diverging behind, back of the head faintly striated. Two hairs in front of the anterior ocellus, one near the margin of each compound eye,

[1] $a—\sigma\eta\mu a$ = without character.

one in front of, and one behind each posterior ocellus, and four or five shorter ones behind each eye. Eyes black. Ocelli forming an almost equilateral triangle, reddish-brown crescents present, but not very distinct. Mouth-cone bluntly pointed, reaching about two-thirds across the prosternum. Maxillary palpi three-jointed (Fig. 2*a*). Labial palpi two-jointed, the basal segment very short and broad (Fig. 2*b*). Antennae seven-segmented, a little more than twice as long as the head. Colour brown, with the apical part of the

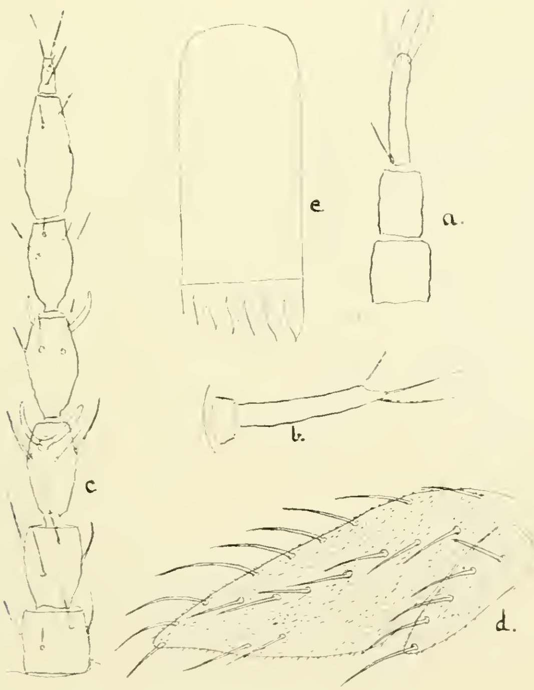

Fig. 2.—*Bagnallia ascmus*, n.sp.

a, maxillary palp; *b*, labial palp; *c*, antenna (from above); *d*, wing; *e*, ventral pleurite of fifth abdominal segment.

second joint, and the whole of the third joint, slightly lighter. First segment short and cylindrical; second slightly constricted at the base, truncate at the apex; third with a short distinct stem, fusiform; fourth fusiform; fifth constricted at the base, apex sub-truncate; sixth the longest; seventh about twice as broad at the base as at the tip. A forked trichome on the dorsal side of the third segment, and one on the ventral side of the fourth (Fig. 2*c*).

Prothorax as long as the head, slightly widening behind; posterior angles rounded, each with two long spines; four or five smaller ones along the hind margin on each side. Pterothorax a little wider than the prothorax, its front angles rounded. Legs of the same colour as the body, with the tarsi and the distal portion of the tibiae, more particularly on the fore-leg, slightly lighter; fore-tarsus unarmed, fore and mid tibiae with only weak spines, hind tibiae with two spines at the end internally, and a row of six or seven along the inner margin. A few spines on the first joint of the hind tarsus. Wings rudimentary, barely reaching beyond the pterothorax, fore pair slightly tinged with brown, with seven spines on the rudiment of the fore-vein, two on the hind vein, and nine along the costal margin (Fig. 2*d*). Hind wings almost transparent, slightly shorter than the fore-wings.

Abdomen normal, hairs short except on the ninth and tenth segments. The tenth segment about as long as broad at the base. The rudiments of the eleventh segment distinctly visible as three small chitinised plates, one dorsally, and two smaller ventrally. The ventral pleurites of the second to seventh segments are strongly pectinated behind (Fig. 2*e*).

Egg.—There are two apparently fully-developed eggs visible in the abdomen of one of the specimens, lying longitudinally and slightly overlapping, the anterior one occupying the fourth and fifth segments, the other part of the fifth, the sixth, and part of the seventh. They are kidney-shaped, and about 0.25 mm. long by 0.13 mm. broad.

Type in the Hope Department, Oxford University Museums.

Described from three specimens; one taken in a flower of buttercup (*Ranunculus*, sp.) on the University Farm, Cambridge, England on the 8th of May, 1911, and two others taken at the same spot in flowers of dandelion (*Taraxacum officiniale*) on the 22nd of April, 1913.

This species is easily separated from *calcarata*, Uzel, by the absence of the fore tarsal tooth; from *capito*, Karny, *klapaleki*, Uzel, *palustris*, Reut., *longicollis*, Uzel, and *viminalis*, Uzel, by the colour, or the relative length, of the segments of the antennae; from the two latter it is also distinguished by its larger size. It differs from *discolor*, Hal., in its colour, from *angusticeps*, Uzel, in the size and in the colour of the fore tibiae, from *dilatata*, Uzel, in the normal width of the abdomen and the colour of the fore tibiae, and from *agnessae*, Bagnall, by the slightly smaller size and relatively longer antennae.

Bagnallia variabilis, n. sp.

Female. Measurements.—Head, length, 0.12 mm., width, 0.125 mm.; prothorax, length, 0.13 mm., width, 0.16 mm.; pterothorax, length, 0.27 mm., width, 0.225 mm.; abdomen, width, 0.27 mm.; wing, length (from tip of basal lobe), 0.65 mm., width (about half-way along), 0.044 mm.

Antennae.—

Segment	-	1	2	3	4	5	6	7
Length (μ)	-	22	39	43	42	34	45	12
Width (μ)	-	26	24	20	21	18	21	8

Total body length, 1.2 mm.; antennae, 0.26 mm.

Colour, dark grey-brown, the pterothorax slightly more yellowish. The third segment of the antennae paler and also the tarsi and the end of the tibiae. Wings pale brown.

Head very nearly as long as wide, not constricted behind. Cheeks slightly arched. Two small setae near the margin of each eye just anterior to a line through the front ocellus. One small seta in front of each posterior ocellus, and five small setae in a line from behind each posterior ocellus to behind the eye, the last being a little separated from the other four. A few other very small setae scattered over the hind part of the head, which is distinctly striated. Eyes rather large, not projecting, black; the space between them equal to the width of the eye. Ocelli distinct, close together, forming an obtuse triangle. Crescents distinct, red brown, largest on the posterior ocelli. Mouth cone rather long, reaching nearly across the prosternum. Maxillary palpi three segmented, the middle segment being the shortest and the distal one the longest. Three sense hairs on the tip of the last segment and one at its base. Labial palpi two segmented, the basal segment very short, four sense hairs at the tip of the distal segment. Antennae more than twice the length of the head; the first segment short and stout, the second longer, the third with a distinct pedicel, the fourth as long as the third, the sixth the longest, slightly longer than the fourth, the seventh short. Colour: the first and second dark brown, the former being a little more opaque than the latter; the third much paler, sometimes slightly darker at the tip; the fourth to seventh as dark as the second. A forked trichome on the distal side of the third segment, and one on the ventral side of the fourth.

Prothorax longer and wider than the head; two very short curved spines at each front angle, and two long spines at each hind angle; also about six smaller spines along the hind margin of the pronotum. A number of small setae scattered over the pronotum.

Pterothorax stout, much wider than the prothorax, front and hind angles rounded. Legs brown, the tarsi and the ends of the tibiae paler, two stout spines on the inner side of the apex of the hind tibiae. Wings fully developed, fore wings light brown, hind wings almost clear. The number of spines on the veins of the wings is very variable; 24—28 on the costa, 15—19 on the hind vein, and 8—13 on the outer half of the fore vein. Sometimes on the fore vein the space between the outer and the basal spines is quite small, the two series appearing almost continuous.

Abdomen normal, the ventral pleurites are pectinate posteriorly. The long setae on the ninth and tenth segments are about as long as the tenth segment.

Described from five females beaten from *Pinus* and three females in flowers of *Genista anglica* close by, on May 11th, 1913, at Matley Bog, New Forest, Hampshire, England.

Type placed in the Hope Department, Oxford University Museum.

The two genera *Thrips* and *Bagnallia* approach very close to one another, and it is doubtful if they are really distinct. For the present, however, we place this species in the latter genus on account of its relatively long head. It is easily distinguished from the other members of this genus by the large and varying number of spines on the outer half of the fore vein.

Stenothrips graminum, Uzel.

Bagnall has already (Journ. Econ. Biol., vol. vii, p. 194) recorded this species from near Oxford and Tring. I have taken it in the former locality and also at Wicken, Cambridgeshire on oats.

Sub-Order Tubulifera.

Fam. **Phloeothripidae.**

Megathrips nobilis, Bagnall.

(Fig. 3).

A single dead male and three larvae of this species were beaten from a sedge stack at Wicken Fen, Cambridgeshire, in March, 1912. The larval form being as yet undescribed, I give the following short description.

Old larva.

Total body length, 2.8 mm.; head length, 0.4 mm.; antennae, length, 0.7 mm.

Colour, vermilion and brown; the head, prothorax, legs, and last three abdominal segments are more strongly chitinised, and also, to a slightly less degree, a row of small spots on each of the abdominal segments 1—7, and on the metathorax, and two rows on

the mesothorax. In all these parts the chitin is darker in colour, obscuring the red which lies underneath and which is visible at the sutures and on the rest of the body. There is, on the head, a dorsal longitudinal suture between the chitinised plates, starting from the posterior margin, widening gradually in front, and finally dividing into two branches, one of which runs to the base of each antennae just in front of the eye. In this broad suture just at the fork is a small round plate. There is also a slightly depressed and less chitinised strip from each lateral posterior edge of the head, reaching forwards and dorsally to about half way along the head (Fig. 3*a*.). The dorsal suture on the head is continued behind between the two dorsal prothoracic plates. The tenth abdominal segment is

Fig. 3.—*Megathrips nobilis*, Bagnall. Larvae.
a, head and prothorax of old larva; *b*, antenna of ditto; *c*, antenna of younger larva.

thickly chitinised all round, the ninth is thickly chitinised above but slightly less so beneath. On the eighth segment there are two large dorso-lateral plates, which nearly meet above, and two smaller ventral plates. On the abdominal segments 1—7 there are eight small plates, two dorsal, two dorso-lateral, two lateral and two ventral, each bearing a hair. Tubus not quite twice as long as broad at the base.

The antennae are strongly chitinised. First joint dark, second dark, light at the tip, third light, dark at the tip, the fourth light at the base, the rest dark. (Fig. 3*b*.).

Younger larva.—Length, 1.8 mm.; head, length, 0.21 mm.; antennae (Fig. 3*c*.), length, 0.39 mm.

Red colour less bright, chitinisation much less strong, except on the last two abdominal segments and the antennae, which are already fairly dark, the latter, however, being more unicolourous than in the older larva.

Described from one large and two smaller larvae.

Cryptothrips dentipes (Reuter).

Both sexes common, hibernating in the sedge stacks at Wicken Fen, Cambridge.

Cryptothrips major, Bagnall.

This species was described from a single female, taken by Mr. Bagnall in Norway on December 16th, 1912.[1] I was fortunate enough to find it in some numbers in a stack of Pea sticks (mostly Hazel) stored for the winter at Merton, Surrey, taking altogether 9 females, 6 males, and 13 larvae. As the male and the larva are hitherto unknown, I give short descriptions.

Male smaller than the female (in the proportion 3 to 5). Front tarsi lighter than in the female, with a large claw on the first joint. Otherwise similar to the female.

The larvae are orange-red in colour, with the last two segments, the antennae (except for the first joint) and the tibiae dark brown, and the head and prothorax lighter brown. The femora are dark at the basal half and light in the apical half. The arrangement of the chitinised plates on the head and prothorax very similar to that shown above for *Megathrips nobilis*, Bagnall. Each tarsus bears two small claws.

Cephalothrips monilicornis (Reuter).

Mr. Bagnall has already recorded (Ent. Mon. Mag., 2nd series, 1912, vol. xxiii, p. 190) that I took two specimens of the winged form of this species at Matley Bog, in the New Forest. There was at that time only a single other winged specimen known (from Poland), but I have since found it not uncommon at Wicken Fen, Cambridgeshire, where out of 27 specimens beaten from a stack of sedge in the winter, 18 were winged.

Hoplothrips corticis, Serville.

(= *Acanthothrips nodicornis*, Reuter).

Several specimens were beaten from a bundle of faggots in Bagley Wood, near Oxford, on August 7th, 1912.

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[1] Ent. Mon. Mag., 2nd series, 1911, vol. xxi, p. 60.

FURTHER NOTES ON NEW AND RARE BRITISH THYSANOPTERA (*TEREBRANTIA*) WITH DESCRIPTIONS OF NEW SPECIES.

By

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It is particularly pleasing to note that Mr. C. B. Williams has taken up the study of the Thysanoptera and with gratifying results. Our work of the past year has not only considerably added to our knowledge of the British species, but has shown me that this group of the British fauna is very much richer than I had ever anticipated.

Our British list now stands at about 95 species, but this includes one or two critical forms, the descriptions of which I have held back until I have had the opportunity of comparing specimens with certain types in the Vienna Hofmuseum.

During the year Williams has discovered, and is bringing forward in a paper to be published shortly, *Rhipidothrips brunneus*, n. sp., *Euthrips badius*, n. sp., *Bagnallia asemus*, n. sp., *Bagnallia variabilis*, n. sp., and *Cryptothrips major*, Bagnall (originally described from a single Norwegian example), as new to the British fauna, and of these I have had the pleasure of taking *Euthrips badius* and *Cryptothrips major*. In two short papers I have myself brought forward *Melanothrips ficalbii*, Buffa[1] (previously only known from Italy), *Haplothrips distinguendus* (Uzel) and *Haplothrips juncorum*, Bagnall,[2] and in the present contribution *Scirtothrips ulmi*, n. sp., *Dendrothrips degeeri*, Uzel, *Thrips paludosus*, n. sp., *Thrips palustris*, Reuter, *Bagnallia biformis*, n. sp., and *Bolacothrips nigricornis*, n. sp., are recorded for the first time, the genera *Dendrothrips*, *Scirtothrips* and *Bolacothrips* not being previously represented in the British list.

I am pleased to acknowledge the help I have received from Commander J. J. Walker, Mr. A. H. Hamm, and Mr. J. E. Collins, who have not only placed their intimate knowledge of the Oxford district at my disposal, taking me to many of the best hunting grounds, but have helped me in other ways.

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[1] Journ. Econ. Biol., Sept., 1913.

[2] Ent. Mon. Mag., Oct., 1913.

Family **Aeolothripidae**.

Rhipidothrips gratiosus, Uz.

Another example (female) from the banks of the Cherwell, Oxford, in June, where I took the first examples last year. In moderate numbers, including a few examples of the male, on oats, Boar's Hill, New Hincksey, Ferry Hincksey, Abingdon and Cothill (Berks.), July and August, 1913.

Family **Thripidae**.

Sericothrips staphylinus, Hal.

Females only.—In *Galium* on the railway banks near Yarnton (Oxon.), July, and in *Ulex* on the Tors near Ilfracombe (N. Devon), common.

Frankliniella intonsa (Trybom).

Both sexes occur freely in the Marsh Red Rattle (*Pedicularis palustris*) at Hogley Bog, Cowley, near Oxford, July and August. By general sweeping on the Railway banks near Yarnton, June, 1913. (J. E. Collins and R. S. B.). One female from Wicken Fen (Cambs.), June, 1913 (C. J. C. Pool).

Frankliniella tennicornis, Uzel.

Single females from Wicken Fen (Cambs.), taken by Mr. C. J. C. Pool; near Yarnton (Oxon.), June, and Balsall Common, Warwickshire, September, 1913. First recorded as British last year from a solitary Northumbrian example.

var. **adustus**, Uzel.

Several examples of both sexes from barley, Marston Green, Warwickshire (H. Willoughby Ellis and R. S. B.).

Scirtothrips ulmi, n. sp.

Female.—This species very remarkably approaches *Physothrips ulmifoliorum* (Hal.) in size, shape and type of coloration, but the single bristle at each hind angle of prothorax and the generally shorter bristles, more especially the minute setae of fore-wings, show that it is referable to the genus *Scirtothrips*—perhaps a sub-genus of *Euthrips* (*Anaphothrips*)—and of the section wherein the sixth antennal joint is not divided.

It differs in other important particulars from *P. ulmifoliorum*.

The inter-ocular bristles are absent, and the postero-lateral prothoracic pair are minute. The two bristles on the distal half of the upper vein of fore-wing are widely separated. The eighth tergite is not fringed with minute setae along posterior margin, whilst the ninth tergite has not the pair of prominent dorsal bristles seen in *ulmifoliorum*. These comparative remarks apply almost equally well to *P. latus*, Bagn., which is most nearly related to *ulmifoliorum*.

The relative lengths of the antennal joints are approximately as follows:—

S. ulmi	...	7 : 11 : 13 : 12 : 11 : 15 : 3 : 4.5
P. ulmifoliorum	...	8 : 12 : 16 : 15 : 11 : 16 : 3 : 5

and the fifth joint in *S. ulmi* is not so broadly united to the sixth as in *P. ulmifoliorum*.

Male.—The ninth tergite (in *ulmifoliorum*, simple) is furnished with a pair of short, stout dorsal spines, one on each side of the mid-line, and a second shorter pair nearer to the posterior margin and slightly wider apart.

Habitat.—August and September, 1913, both sexes common. Under and on leaves of common elm, Oddington and Weston-on-the-Green, and in the neighbourhood of Oxford (Oxon.); and at Balsall Common and Marston Green, Warwickshire. On the wych elm, Abingdon (Berks.), and near Kirtlington and Henslow Bridge (Oxon.).

The following key, though containing species of two genera, may be useful.

Distal half of upper vein in fore-wing set with two bristles. Antennal joint 2 darker than 1 and 3.

1. Prothorax with two long bristles at each hind angle (*Physothrips*). Inter-ocular bristles present; setae on fore-wing long and stout and the 2 on distal half of upper vein close together. A pair of long dorsal bristles on 9th tergite and 8th tergite with posterior margin fringed with minute setae. Male (of *P. ulmifoliorum*) without specialized short stout spines on 9th tergite. 2

   Prothorax with one long bristle at each hind angle (*Scirtothrips*). Inter-ocular bristles absent; setae of fore-wing short and weak, the 2 on distal half of upper vein widely separated. 9th tergite without long pair of dorsal bristles, and posterior margin of 8th tergite without fringe. Male with two pairs of short stout spines on 9th tergite.

   Scirtothrips ulmi, n. sp.

2. Size smaller (0.75)[1]; form unusually broad; postocular bristles long. Colour light.

Physothrips latus, Bagnall.

Size larger (1.0 to 1.2 mm.), form normally broad; postocular bristles absent. Colour darker.

Physothrips ulmifoliorum (Hal.) Uzel.

Dendrothrips degeeri, Uzel.

Monographie der Ordnung Thysanoptera, 1895, p. 162, pl. vi, fig. 87.

This species is readily separated from *saltatrix*, Uz., by its darker coloration and much shorter head, whilst the antennae are only 0.2 longer than the breadth of the head. The other two species, *D. tiliae* and *D. saltatrix* might be expected to occur in the South of England.

Distribution.—One female and one male on Alder (*Alnus*) near Watersmeet, Lynmouth (N. Devon), August; numerous females and two males on Ash, Kirtlington Park (Oxon.), September, 1913. Previously known from Bohemia and Italy.

Oxythrips ajugae, Uzel.

In flowers of pine, University Park, Oxford, June, 1912.

Oxythrips parviceps, Uzel.

Common in heather and heath. Lynmouth, Ilfracombe and Lee Bay, North Devon, August; and Coleshill Bog, Warwickshire, September, 1913.

Euthrips (Anaphothrips) badius, Williams.

This interesting thrips was only discovered recently at Wicken Fen by Mr. Williams, who is describing the species under the above name.

I have taken a single female in a sedge stack at Weston-on-the-Green (Oxon.), August, 1913.

Aptinothrips rufus (Gmel.).

Male smaller than female, ninth tergite with one pair of specialized short and very stout dorsal spines, and a more slender pair nearer to the posterior margin, and placed about the same distance apart. My example is unfortunately mounted on its back, and it is difficult to appreciate the true position of these spines.

One example, banks of the Cherwell at Marston Ferry, near Oxford, August 22nd, 1913.

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[1] Re-examination shows *latus* to be smaller than originally described.

Aptinothrips nitidulus, Haliday.

One female on the shore at Clovelly, N. Devon, August, 1913.

Thrips palustris, Reuter.

O. M. Reuter, Acta Soc. pro Fauna et Flora Fennica, xvii, 1899.

In his monograph of the Finnish Thysanoptera the late Prof. Reuter described several interesting species, amongst them *T. palustris* from the Lousewort, *Pedicularis palustris*, which comes nearest to *T. salicaria*. Though I have not yet recorded it, I took this species from the same plant in Southern Norway in the summer of 1909, and I was particularly pleased to find it again when collecting recently at Hogley Bog with Mr. A. H. Hamm. Most of the British examples are lighter than described by Reuter.

Distribution.—Females only, Hogley Bog, near Cowley (Oxon.), in the flowers of the Lousewort (*Pedicularis palustris*), August and September, 1913. Previously known from Finland (Reuter) and Norway (R. S. B.).

Thrips paludosus, n. sp.

Female.—Length, 1.0 to 1.1 mm.

General colour of head and thorax orange-yellow, very lightly tinged with grey; cheeks and frons sometimes greyish-brown. Abdomen greyish-yellow, last two segments dark grey, and segments six to eight sometimes more strongly tinged with grey. Legs yellow, very lightly tinged with grey. Antennal joint: 1, greyish-white; 2, greyish-yellow; 3, lighter yellow to grey-brown, lighter basally; and 5—7, grey-brown. Wings light greyish-yellow, cilia darker. All setae moderately dark.

Head transverse, 0.65 as long as broad and as long as the prothorax; basal third dorsally and laterally striate. Eyes coarsely facetted, pilose. Inter-ocular setae present, small. Maxillary palpi three-jointed, third joint the longest; second joint of labial palpi very long. Antennae about 2.2 times as long as the head, relative length of joints approximately—16 : 22 : 30 : 27 : 25 : 34 : 10; third joint pedicellate, 1 and 2 broader than any of the following; 3 to 5 practically subequal in breadth, and 6 but slightly broader.

Prothorax transverse, 1.8 times as broad as long, with two long bristles at each hind-angle (which are about 0.6 the length of the prothorax), and a series of three short pairs of postero-marginal setae, of which the inmost are the longest. The dorsal surface is very slightly convex, and the hind margin is impressed so that there is a more than usually distinct pre-marginal line which is also set with

a series of short setae and one long one at each angle. The whole surface is irregularly set with short setae including a more or less distinct antero-marginal series. Pterothorax large. Legs moderately long, pilose; hind tibia with a series of short stout spines on the apical half within. Wings long, reaching to seventh abdominal segment; spines on fore-wing prominent, three on apical half of upper vein, the most distal two somewhat widely separated.

Abdomen elongate, narrowing gently to apex from sixth segment. Apical bristles long, about 1.5 times as long as the segments bearing them. Ninth tergite with a pair of dorsal bristles in addition to the postero-marginal series, but only about 0.5 as long and inwardly curved distally.

Male.—Smaller and more slender, head, thorax and abdomen light greyish-yellow. Ninth tergite with six rather long and slender dorsal bristles, four (two pairs) set more or less regularly (two on each side of the mid-line) on a line across the middle of tergite, and the third pair on a lower plane, and not so widely separated as the outer pair of the upper series.

Habitat.—Apparently a bog species. Several examples, including a male, from sedge, and a cruciferous plant in the "peat pits" at Weston-on-the-Green (Oxon.), August, and further examples (females only) from *Erica tetralix* growing at the margin of Coleshill bog, Warwickshire, September, 1913.

This species is separated from *adusta* by its light colour, the coloration of the legs and antennae, and by the longer fifth antennal joints, and from all the little "yellow" species by the grey tip of body. It is further distinguished from *alni* by its larger size and the relative lengths and breadths of the antennal joints: from *albopilosus* by its larger size, the dark setae and wholly dark fifth antennal joint; and from *nigripilosus* by the larger size, shorter prothorax, and in having three setae in distal half of upper vein of fore-wing. *T. paludosus,* unlike *nigripilosus,* does not appear to have any pale depressed areas on the abdominal sternites in the male.

Bagnallia agnessae, Bagnall.

The female ranges from 1.45 to 1.65 mm. and the male from 0.85 or 0.9 to about 1.1 mm. in length.

The male is always brachypterous, the wings being reduced to wing-pads. The female is winged, and there are two forms, a short-winged and a long-winged form, most probably seasonal.

Female.—Forma microptera. The species was originally described from the short-winged form taken at Gibside, in October,

1910. Probably autumnal. The long-winged form was taken plentifully at the same place in the following spring.

Since this was written I have taken two females of this form and one male (brachypterous) at Balsall Common, Warwickshire. September, 1913.

Female.—Forma *macroptera, s.s.* In numbers, Gibside, early June, and at Fencehouses, April to June, 1911. A few examples on the canal banks near Yarnton, Oxon., June, 1913.

In this form the wings reach to the seventh abdominal segment. The fore-wing is smoky brown, light at base, and with a light irregular patch occupying the third fourth. In some specimens this is very noticeable, and the examples with wings folded are distinctly white-banded, as in *Odontothrips phaleratus*. The arrangement of spines, abnormally few, are as in the *forma microptera*.

Bagnallia biformis, n. sp.

A very distinctive species.

Forma typica. Female.—Length, 1.25 to 1.35 mm.

Dark greyish-black, head and abdomen slightly, but not strikingly darker. All femora grey-brown, inclined to be lighter apically, fore and intermediate tibiae yellowish, shaded with grey-brown along margins and near base; hind tibiae also yellowish, at least basal two-thirds usually grey-brown. All tarsi yellow. Fore-wings uniform dark grey, cilia smoky. Antennae with first two joints grey-brown, lighter apically; third light yellow, scarcely tinged with grey; fourth greyish-yellow; fifth to seventh grey-brown to grey-black. In very dark examples the femora and tibiae are dark greyish-brown, especially marginally, and lighter basally and apically.

Head practically as long as broad, and very slightly longer than the prothorax. Eyes not so prominent as in *agnessae,* but slightly bulging; coarsely facetted. Cheeks and ocelli as in *agnessae*; mouth-cone reaching across prosternum. Antennae about 1.75 times the length of the head; relative lengths of joints 3 to 7: 13 : 13 : 12 : 16 : 6. Much the same as in *agnessae,* but with the joints 5 and 6 narrower and more slender, equal in breadth to 4.

Prothorax transverse, 1.5 times as broad as long; two long bristles at each hind angle. Pterothorax 1.2 times as broad as the prothorax, longer than broad. Legs as in *B. agnessae.* Wings reaching to about the seventh abdominal segment; fore-wing with 14 bristles in lower vein, and 1 + 2 (the latter not close together) in the distal half of upper vein. Median vein of hind wing extending almost to apex.

Abdomen elongate, not much wider than the pterothorax; sharply narrowed from base of segment eight to apex. Bristles on segments nine and ten long, longer than the length of the respective segments bearing them. Lateral abdominal bristles much as in *agnessae*, one at each posterior angle of segments two to seven slightly curved.

Male.—Length, 1.0 to 1.1 mm.

Head yellow, cheeks and frons tinged with brown; prothorax light yellowish-brown; pterothorax also yellowish-brown, but deeply tinged with grey-brown, especially in the middle and laterally. All legs yellow; outside margin of femora, and sometimes of the tibiae, lightly (almost imperceptibly) tinged with grey-brown. Wings as in female, but reaching nearly to the ninth abdominal segment. Antennal joints one to four light yellow, two and three very slightly, and one and four more strongly tinged with grey; five to seven grey-brown to grey-black, basal half of five sometimes lighter with yellowish tinge. Abdomen from dark grey-brown to almost black.

Each of the sternites three to seven with a short transverse depression, rounded laterally: from 3 to 3.5 times as broad as long in sternite 7, to 5 to 5.5 times in sternite three.

var. **adusta**, nov.

Female.—Legs lighter, tibiae almost entirely yellow. Pterothorax and abdomen light grey-brown, with exception of the apex (*i.e.*, abdominal segments nine and ten and sometimes part of eight), which is deep greyish- or brownish-black.

var. **melanurus**, nov.

Male.—All abdominal segments, except the last three, yellow lightly tinged with grey, the seventh segment sometimes darker than the preceding.

Distribution.—Both sexes plentiful (the varieties also) in sedge stacks, Weston-on-the-Green (Oxon.), August, 1913.

Genus **Bolacothrips**, Uzel, 1895.

1. Size smaller (female 0.9 mm.). Antennal joints 1-4 yellow, ends of 3 and 4 usually greyish, 5 yellow with apical third dark, 6 dark grey, base or basal half yellow and 7 dark grey. Body setae light. Female, *B. jordani*, Uz.
2. Size larger (male 1.15 mm.). Antennal joints 3-7 wholly dark. Body setae strikingly dark. Male, *B. nigricornis*, n. sp.

Bolacothrips nigricornis, n. sp.

Male.—Length about 1.15 mm.

Light yellow, very faintly tinged with grey; pterothorax and apex of abdomen slightly deeper in colour. Eyes, antennal joints three to seven and thoracic and abdominal spines black.

Ocelli and wings absent.

Head about 0.9 as long as broad across eyes; frons rounded; eyes moderately large and prominent, cheeks slightly arched. Post-ocular and inter-ocular bristles present. Mouth-cone reaching across prosternum; maxillary palpi three-jointed; labial palpi two-jointed and rather longer than usual. Antennae with basal joint short, lighter than head; two, yellow, tinged with grey, rest black; joints three and four roughly ovate, practically sub-equal in length and narrower than two; five, about 0.85 the length of four, distinctly narrower and distally truncate; six, about 1.13 as long as four, elongate ovate, slightly broader than five but narrower than four; style about 0.35 as long as penultimate joint.

Prothorax not quite as long as head; about 1.75 times as broad as long. Two stout and moderately long bristles at each hind-angle, and the antero-marginal, mid-lateral pairs and the pair at anterior angles present and well-developed, not so stout and about 0.5 the length of those at posterior angles. Pterothorax transverse, but little broader than the prothorax. Legs stout, tibiae as broad as femora; well-furnished (especially the tibiae) with somewhat long setae, which are not, however, so strikingly dark as those on the thorax and abdomen.

Abdomen broadest at about segments four and five; apical bristles long and stout. Tergites two to eight furnished with several (usually three pairs, *i.e.*, six) long dorsal bristles, in addition to the usual bristles at posterior angles, more or less regularly on a line across middle and extending to or beyond posterior margin of the respective segments bearing them.

Sternites three to seven with a very short, strongly transverse depression, from ten times as broad as long on sternite seven to about twenty-five times on three and four.

Distribution.—One male beaten from a sedge stack with *Bagnallia biformis*, n. sp., *Euthrips badius*, Williams, and *Anthothrips distinguendus*, Uzel, at Weston-on-the-Green (Oxon.), August, 1913.

Stenothrips graminum, Uz.

Very common on various grasses in May and June, and on cereals, especially oats, in July. Oxford, Cowley, Yarnton, Odding-

ton and Weston-on-the-Green (Oxfordshire), and Abingdon, Cothill, Boars Hill, Ferry Hincksey and New Hincksey (Berkshire). A few examples, Ilfracombe, on oats, and Lynmouth, on grass in the woods near Watersmeet, August, 1913. Now known from Oxfordshire, Berkshire, Hertfordshire, and North Devon.

Platythrips tunicatus (Hal.).

Females only.—From heather, Ravenscar (Yorks.), September, 1910. A few examples in furze (*Ulex*) on the Tors, Ilfracombe (N. Devon), and in sedge stacks, Weston-on-the-Green, August, 1913. The male is as yet unknown.

SOME FURTHER REMARKS ON THE SCIENTIFIC WORK ON THE CEYLON PEARL BANKS.

By

H. LYSTER JAMESON, M.A., D.Sc., Ph.D.

Mr. Southwell's paper in the *Journal of Economic Biology* for February, 1913, demands a rejoinder on my part.

The matters touched upon by Mr. Southwell fall naturally into two categories,—matters of opinion and matters of observation or alleged fact.

I propose in this paper to confine my attention to the latter; as, until Mr. Southwell or someone else can contribute new data in support of, or in opposition to, the several opinions that have been expressed on the subject by different investigators and compilers, I cannot see that any useful scientific purpose will be served by pursuing the theoretical side of the controversy.

I will deal with the several questions of observation and fact, that arise out of Mr. Southwell's paper, *seriatim*. Before doing so, however, it is desirable to say a word about Mr. Southwell's methods of argument. He does not distinguish sufficiently clearly between theory and observation. He often begins by making suggestions and enunciating hypotheses, and, as he goes on, elevates these into apparent statements of the results of observation and experiment.

I.—The Duration of the Planktonic Stage of the Pearl Oyster, and its Bearing on the Question of the Replenishment of the Ceylon Banks from the Madras Coast.

Mr. Southwell states on page 27 of his paper that the larvae "live on the surface of the ocean for at least five to seven days, when, having acquired a shell, they drop to the bottom in the position in which they happen to be in (*sic*) at the time"; and on page 28 he takes "seven days as the maximum time occupied by the pelagic stage of the oyster." On page 29 he says: ([1]) "Prof. Herdman states that the larval stage occupies about seven days. My own results, which I did not publish, gave a slightly shorter

[1] As Professor Herdman's authority is invoked, it is well to point out that his statements as to the duration of the larval stage in part I, p. 127 and part V, p. 114 of his Report (1) were tentative and guarded, and not, as Mr. Southwell implies, dogmatic assertions.

duration; probably the time occupied varies a little with the temperature and other conditions. The determination is sufficiently accurate for the purpose in hand. Had a multitude of experiments been carried out, and the period fixed with the greatest scientific accuracy, it could not possibly have affected the conclusions suggested in this paragraph."

Mr. Southwell, taking the supposed seven days' larval period as one of his premises, argues that a continuous strong monsoon during seven days would, if oyster larvae were present on the Tuticorin grounds, result in the spat being deposited on the Ceylon banks, whereas weaker monsoons would result in the larval oysters not reaching the Ceylon beds. He sums up his argument on page 33 thus: "The scientific work done up to date has conclusively shewn that natural supplies of pearl oysters are brought to the Ceylon Banks, from the south-east coast of India, by the agency of surface currents, and that this can only take place during very strong and prolonged south-west monsoon." It will be seen that the whole of this assertion hangs upon a number of hypotheses, one of which is the insufficiently substantiated statement that the maximum duration of the free swimming stage of the oyster is about seven days.

It may ultimately prove that the free swimming stage of the Ceylon pearl oyster has a duration of only five to seven days, or even less; but it cannot be too strongly urged that, until Mr. Southwell or somebody else gives to the public details of experiments leading to this conclusion, the hypothesis that the alternation of barren and productive cycles in the Ceylon Pearl fisheries is a function of the strength of the monsoon and the seven days' planktonic stage of the oyster should be received with great caution.

Indeed, in view of the allegations which have been made by Mr. Southwell, (6) p. iii, and by the Chairman of the Ceylon Company of Pearl Fishers, Ltd., at the 1911 Meeting, quoted at the beginning of my previous paper (3), to the effect that the banks are not only barren of pearl oysters, but of other species of molluscs and forms of marine life, it may well be that the chief factor will have to be sought among the physical and biological conditions which determine the variations in the qualities of the water and the food supply.

II.—The Supposed Presence of the Remains of Cestode Larvae in the Nuclei of Ceylon Pearls.

Mr. Southwell says (p. 32):—"During my period of office I examined large numbers of cyst pearls collected on the spot. Their number is well over 1,200. I have often found remains of a cestode

larva inside such pearls. Not invariably, but frequently. I have never published the results. The reports which I have published from time to time represent, as I stated therein, but a fraction of the work which has been done." And on page 34: "The present writer has repeatedly found a larva similar to that found in the globular cyst forming the nucleus of a Ceylon cyst pearl." The identification of the nuclei of pearls is surrounded with so many difficulties that Mr. Southwell should publish particulars and drawings, if he wishes his statement to receive serious consideration. A worker like myself, who has as often as not to obtain even the minimum amount of material necessary for research at the top market price, may be excused if he cannot contemplate the sacrifice of over twelve hundred "cyst" pearls, with no more detailed scientific result than the two bare statements quoted above, without regarding the proceeding as a grave waste.

Apparently Mr. Southwell differs from Professor Herdman and Mr. Hornell in that he considers that only the smallest of the larvae become pearl nuclei. He says on page 32: "No one believes that such larvae [*i.e.*, the larger larvae] ever became the nuclei of pearls. But it is highly probable that larvae, just born by a process of endogenous reproduction, may die, and that, owing to the irritation set up, a pearl sac may be formed before the parasite has acquired a cyst at all. Moreover, such an accident is likely to happen. . . . ." In Mr. Southwell's summary two pages later this conjecture with regard to the origin of the pearl sac is raised to the dignity of a statement of fact: "When a larval cestode occurs as the nucleus of a pearl, it is a minute specimen, probably just born by a process of endogenous reproduction, and does not measure more than 1 mm, [1] and frequently less, the larva being enclosed in a pearl sac before an external cyst is formed round it." These statements require elucidation with drawings and notes made from the specimens at the time, if they are to find a place alongside of more serious work on the genesis of the pearl sac.

Mr. Southwell (p. 31 and p. 34) accounts for my failure to find cestode remains in the pearls I examined by supposing that I overlooked them, owing to their small size.

I think, if Mr. Southwell will confer with any biologist who is familiar with the everyday technique of modern microscopical research, he will be able to satisfy himself that it would be impossible for a microscopist of ordinary skill, studying sections of pearl nuclei with the degree of detail indicated by the drawings which illustrate

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[1] Probably Mr. Southwell means 0.1 mm.

my paper, to overlook the presence of the remains of cestodes in any of the pearls examined, even if much smaller than the smallest larvae yet recorded from the Ceylon pearl oyster.

But it would be much better if, instead of discussing possibilities, Mr. Southwell would publish positive evidence, based on the unparalleled opportunities which the 1,200 cyst pearls must have afforded him. If he cannot do this, I have no doubt some authentic Ceylon pearls could be purchased in the London market or elsewhere. And I myself am quite willing, in view of the costly nature of these experiments, to make him an offer. I will defray the cost of any pearls, in a lot to be purchased by mutual agreement, which prove, after examination by a competent and impartial authority, to contain the remains of Cestodes as nuclei. More than this I am not inclined to do, as I feel that I have already expended as much as I should in obtaining, in connection with purely private researches, material for the purpose of revising and criticising official results, obtained at great cost to the Ceylon taxpayer and the investing public, by men who were afforded such opportunities as very seldom fall to the lot of the biologist.

III.—Identity of the Cestode Larvae.

Whether or not the smaller larvae in the Ceylon pearl oyster are, as Mr. Southwell claims, derived from the larger ones by a sexual multiplication must remain an open question until further particulars are produced.

In the absence of evidence to the contrary, it is open to question whether the two cases cited by Mr. Southwell in his 1910 paper (5) page 173, may not have been instances of the presence in the Ceylon pearl oyster of yet another species of Cestode, which—like that investigated by Mr. Hornell and Dr. Willey in *Placuna*—habitually reproduces in this way.

The statement of the case on page 30 of Mr. Southwell's paper implies that the origin of all the smaller larvae found in the pearl oyster from the larger ones is a fact settled once for all, which is by no means admissible.

I must correct Mr. Southwell on certain points of fact respecting the globular larvae. It is not the case that the cestode characters of these larvae "are even at best but ill defined" (page 30). They are typical tapeworm scolices, comparable in everything, except the absence of suckers, to the heads of mature worms such as the members of the genus *Tylocephalum* and allied forms. Moreover, Mr. Southwell is labouring under a misapprehension in stating, on

page 34, that the names I have given to these larvae cannot stand. If Mr. Southwell will refer to Professor Herdman's Report (1, Part II, page 88) he will find that the name *Tetrarhynchus unionifactor* was given by Shipley and Hornell to an elongated larva, with four proboscides.

Mr. Southwell ought to be aware that under the established international rules of zoological nomenclature, the name *Tetrarhynchus unionifactor* belongs in the first instance to this larva. It also embraces the adult form, since discovered in various elasmobranches. When the evidence against the assumption that the spherical larvae represented younger forms of this worm was shown to be considerable, it became expedient to apply to the spherical larvae distinct names. This I did. Unless and until it can be shown that these parasites are the young of *Tetrarhynchus unionifactor*, or of some other already described form, the names I have given belong to them.

At the bottom of page 30, Mr. Southwell states that " there is not the slightest ground of support " for the theory that the adult of the larva I have named *Tylocephalum ludificans* occurs in the ray *Aetobatis marinari*. I think I have shown that there are reasonable grounds for expecting that a worm discovered in this ray by Shipley and Hornell, and overlooked by them when describing their material, may prove to be the adult of this cestode.

IV.—Frequency of Occurrence of Tylocephala in Different Ceylon Fishes.

On page 31, after a line in inverted commas, which appears to be intended for a quotation from my paper,[1] Mr. Southwell says he is able " to state positively that at least 99 per cent. of the representatives of the genus *Tylocephalum* on the Ceylon Pearl Banks are found in small species of Trygon which are incapable of eating oysters. Although I have examined large rays almost daily over a period of 5½ years, I do not remember, and I have no record of ever having obtained, a single representative of the genus *Tylocephalum* from a large ray." This statement is of interest, as

[1] Every quotation made from my work by Mr. Southwell is inaccurate, in wording, or punctuation, or both. He is even unkind enough to transpose my words on page 24, so as to make it appear that I was guilty of using a split infinitive; a literary idiosyncracy, by the way, to which Mr. Southwell's own writings betray some partiality. It is, perhaps, too much to expect that a critic who seems unable even to transcribe short written sentences correctly, will succeed in giving an accurate rendering of the meaning of the writings he criticises. One might even be excused for wondering whether his scientific observations may sometimes be characterized by a similar lack of precision.

99 is a very high percentage, especially when it represents, as would appear from Mr. Southwell's words, data from thousands of rays, but it is quite out of keeping with Shipley and Hornell's results (summarised on page 283-4 of my paper (4)).

V.—The Marichchukadde Tank.

Mr. Southwell says, with regard to this, "the whole concern was purely an experiment. An outline of this experiment was only placed before the Company in order to obtain necessary funds for its prosecution," and lower down, "The matter was not a proposal, but an experiment, and in a very small way, a successful one."

On the other hand, Sir West Ridgeway, at the 1909 meeting of the Company, said: "Mr. Southwell has recommended the establishment of an oyster hatchery at Marichchukadde, and we have already acted upon his advice. At a cost of only £20 a hatchery tank has been built on the foreshore at that place, where adult oysters will be isolated and the spatfall collected without danger to its existence from its enemies. This spatfall will later be transplanted to the open sea"; and lower down: "by these means, Mr. Southwell says, he has every reason to hope, from his experience and experiment, that totally 'blank' years will be obviated."

It seems quite impossible to reconcile these two accounts of the affair.

VI.—Other Matters.

Before concluding this paper I may perhaps be permitted to refer to one or two points raised in two recent papers by Dr. Joseph Pearson (8) and (9), who, in addition to his duties as Director of the Colombo Museum, holds the post of Marine Biologist to the Government of Ceylon, and upon whom the scientific supervision of all matters relating to the Pearl fishery has devolved, since the cancellation of the Company's lease.

On page 219 of the first of these papers Dr. Pearson criticises my suggestion as to the importation of a few thousands of spat, and his remarks convey the misleading impression that I proposed to *replenish the pearl banks* in this way. Reference to page 19 of my paper (3) will make it quite clear that the suggestion was that the *feasibility of protecting young oysters with wire netting, the demonstration of which was one of the conditions under which the Ceylon Government would have been prepared to re-consider the terms of the lease under which the banks were conceded to the now defunct Ceylon Company of Pearl Fishers, might have been tested in this way.*

In his second paper Dr. Pearson, after expressing the opinion that the negative evidence produced by my examination of the pearl nuclei cannot be regarded seriously by those who believe in the cestode theory, goes on to say: "On general lines the cestode theory agrees very closely with the results of Jameson's own work on *Mytilus*, and if he accepts the absence of a vermian nucleus from any of the Ceylon pearls examined by him as a conclusive argument against the vermian theory of pearl production, he will have to explain away the results he obtains from his *Mytilus* researches."

With Dr. Pearson's personal opinion on the comparative value of evidence I have no concern. But I must point out that I have never stated that I regard my work on the Ceylon pearls as furnishing any argument against the "vermian theory" of pearl production, if by "vermian theory" Dr. Pearson means the theory that in certain species of molluscs the organism that stimulates the production of pearls is a particular kind of worm. I have merely maintained that there is no sufficient published evidence to warrant a scientific zoologist in accepting the Cestode theory, *i.e.*, the theory that *Ceylon* pearls are normally, or indeed even occasionally, formed around the globular cestode parasites which frequent the oyster. Nor is there any necessity, as Dr. Pearson declares, for me to explain away the results of my *Mytilus* researches, in order to harmonise them with what I find in the Ceylon Pearl Oyster. Reference to my papers (2), (4), will make it quite clear that there is no such close agreement as Dr. Pearson suggests between the trematode origin of pearls in *Mytilus* and the supposed relation between pearls and cestodes in the Ceylon Pearl oyster. In fact, the difference between the two cases is one of the strongest arguments I have adduced against the Cestode theory.

A public Official, in a Report to his Government on a highly technical matter, ought to be specially careful to represent correctly the views and observations of other workers on a subject which has been entrusted to him.

REFERENCES.

1. **Herdman, W. A.**—Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar. London, 1903-6.
2. **Jameson, H. L.**—On the Origin of Pearls. Proceedings of the Zoological Society, 1902, vol. i, pp. 140-169.
3. **Jameson, H. L.**—An examination of the causes which have led to the failure of the Biological Work recently undertaken on the Ceylon Pearl Fisheries. Journ. Econ. Biol., Feb., 1912, vol. vii, pp. 10-22.

4. **Jameson, H. L.**—Studies on Pearl Oysters and Pearls. I. The Structure of the shell and pearls of the Ceylon Pearl-Oyster (*Margaritifera vulgaris*, Schumacher); with an examination of the Cestode Theory of the Pearl production. Proc. Zool. Soc., 1912, pp. 260-358.

5. **Southwell, T.**—A Note on Endogenous Reproduction discovered in the larvae of *Tetrarhynchus unionifactor* inhabiting the tissues of the Pearl Oyster. Ceyl. Marine Biol. Reports; Pt. iv, May, 1910, No. 7, pp. 173-4.

6. **Southwell, T.**—Ceylon Marine Biological Reports. Part VI, January, 1912.

7. **Southwell, T.**—A Brief Review of the Scientific Work done on the Ceylon Pearl Banks since the year 1902. Journ. Econ. Biol., Feb., 1913, vol. viii, pp. 22-34.

8. **Pearson, J.**—A review of the scientific work on the Ceylon Pearl Banks from 1902 to 1912. Spolia Zeylanica, vol. viii, pt. xxxii, Jan., 1913, pp. 205-222.

9. **Pearson, J.**—Marine Biology. Ceylon, Administration Reports, 1911-12.

CONTRIBUTIONS TO A KNOWLEDGE OF "THE SNAP-BEECH" DISEASE.

By

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With Plates III and IV.

Diagnosis and Definition of the Disease.

The trunks of beech-trees attacked by the disease described in this paper, usually snap off at a more or less constant height of 15-20 feet from the ground. The mode of fracture is very characteristic, being approximately transverse across a portion of the trunk, but oblique across the remaining part, so that a large jagged splinter, about 2 feet long, remains. This is due to the fact that the wood on the former side is diseased, and consequently weak, for a considerable distance above and below the region of fracture, but is sound on the latter side. The base and upper parts of the trunk are sound.

The disease may be called "The Snap-Beech" Disease.

The fructifications of one particular fungus, *Polyporus adustus,* Fr., are always present in intimate connection with the diseased part of the tree; no other fungus is habitually present.

Sources of the Disease.

I. The disease was brought to notice on the estates of the Earl of Buckinghamshire, at Great Missenden, where it had wrought considerable damage.

II. On an estate at Tring, in Hertfordshire, where the woods consisted mainly of beeches, a number of trees were killed by the disease. In every case fructifications of *Polyporus adustus* were found in the region of the fracture. The bark of several of the trees was covered with the Beech-Coccus, and *Nectria ditissima* was present to a slight extent on some of the trees. In one particular specimen the trunk had cracked half-way across, but the "snap" across the remaining half did not occur till the tree was felled. There were old fructifications of *Polyporus adustus* in the crack, which had evidently been formed some time before felling. The

height of fracture in one fallen tree was 17 feet, and fructifications of the same fungus were noticed at a height of 7 feet from the ground. There was an old wound 5 feet from the base. *Nectria ditissima* was present to a slight extent on the tree, and the bark was covered with the Beech-Coccus. The wound left by a fallen branch was clothed with fructifications of *Polyporus adustus*.

III. At Burnham Beeches a few diseased trees were found. The trunk of one had been broken in a storm, and the snap had occurred at a height of 10 feet (an exception to the general rule). There were numerous fructifications of *Polyporus adustus* just below the jagged splinter and down to 3 feet from the ground; fructifications of the same fungus occurred plentifully on the fallen upper part of the trunk.

From the close and constant connection of the fructifications of *Polyporus adustus* with the diseased wood, it seemed very probable that the "Snap Beech" disease was initiated by this fungus. From the general distribution of the fungus in diseased trees, and its analogy with other wood-destroying fungi, it is safe to assume that the fungus responsible for the disease is a wound-parasite.

Hitherto *Polyporus adustus* has always been described as a saprophyte, though a few writers have suspected it of being a facultative parasite. In a paper by Boodle and Dallimore,[1] on "The Beech Coccus," the following appears in the summary:—

"A conspicuous fungus was present on a large number of dead and dying trees, and was often seen accompanying the *Nectria*. The fructification was greyish, fan-shaped, and often 2-3 inches across. It has been identified as *Polyporus adustus*, Fr., and although it may be merely saprophytic, and not harmful to living trees, it has been suspected of having parasitic tendencies (Massee, Diseases of Cultivated Plants and Trees, p. 387). . . . . The frequency with which trees broken off at 15-20 feet from the ground are met with appears to us to require more than passing notice. The fact of their breaking at this point is due to the wood becoming rotten in this region, though it is healthy above and below. As the fructification of *Nectria ditissima* is chiefly to be seen in this region, it is thought that this fungus may be principally responsible for the rottenness of the wood. The fungus being a wound-parasite, an explanation of the localisation of attack should be attempted. Wounds made by fallen branches would account for the entrance of the fungus, but the badly diseased places would then be expected to occur on various parts of the trunk from base to summit, therefore some other

[1] Boodle and Dallimore—page 342. See Bibliography.

cause must be looked for. It has occurred to us that this may be sunburn following thinning of the trees. During a certain part of the day this portion of the trunk, which had hitherto been shaded, may be exposed to the sun and strongly heated, while the upper and lower parts of the trunk remain shaded. The heating would be likely to kill the bark, with the result that it would probably crack and enable fungus spores to gain an entrance.

"Fructifications of *Polyporus adustus* are also common on the same region of the trunk."

In the same paper the writers conclude that "while the Coccus is doing very little harm, certain fungoid pests account for a serious amount of injury, which is usually credited to Coccus." They indicate *Nectria ditissima*, and a root parasite, *Melogramma spiniferum*, as causing serious damage to the trees, but seem to attach no importance to the presence of *Polyporus adustus*.

The symptoms of the disease described by these writers seem to be identical with those of the "Snap-Beech" disease.

Criticism of the above.

(1) The "Snap-Beech" disease cannot be caused by *Nectria ditissima* because:—

(*a*) This fungus is not usually present.

(*b*) The symptoms of the disease caused by *Nectria ditissima* are quite different from the peculiar symptoms of the "Snap-Beech" disease.

(2) Sunburn is not the cause of the entry of the fungus, because the distribution of all the diseased trees examined and the history of the infected parts of the wood show that they have not been exposed to the risk of sunburn after thinning.

Professor Percy Groom contributes the following remarks on the possible entry of the fungus and the peculiar mode of fracture:—

"The fracture of the beech-trunk is characteristic not only in form (as was first pointed out to me by Lord Buckinghamshire), but also in the relative constancy of position. In seeking an explanation of this latter feature it must be noted that the points of original infection and of fracture may not coincide.

"The evidence is against sunburn as being the cause of infection at the point of fracture, and there is no evidence of attacks by animals which admit wound fungi at this particular point. Still less is there evidence that either of these causes is ultimately responsible for fracture at the definite height up the trunk. There is, how-

ever, one external factor, namely the wind, that may be responsible for such localized infection, or, more probably, rupture.

"Were the trunk of a beech-tree perfectly cylindrical, and did it break across as a consequence of the wind acting on the crown, rupture would take place at the base of the trunk. But if the trunk were a cone, and were the taper in all ages of trees similar, and, at the same time, were the profile surface of the crown proportionate to the dimensions of the tapering trunk, then the trunks of trees of all ages would break at the same height above the ground if ruptured by the wind acting on the crown (so Professor J. Perry informs me). The taper in question may be that of the original trunk, and might conceivably lead to infection at a definite height owing to incomplete rupture in the form of a crack; or the taper in question may be that of the sound wood of a diseased trunk, so that ultimate fracture takes place at a definite height. It is conceivable, too, that unequal developments of the crown of the diseased tree could alone, or with the aid of the wind, cause fracture at a constant height, but I, unfortunately, did not examine the crowns of the diseased trees in sufficient detail to observe any stronger development of the crown on the sound side."

[It is worthy of note that the attacks of *Polyporus betulinus* on the Birch causes an effect somewhat similar to that produced by the "Snap-Beech" Disease. The trunk snaps off, but the break is completely transverse. The fungus evidently advances rapidly in a transverse direction, so that the trunk is locally rotten completely across. The trunks break off at very variable heights, fractures at 9 feet, 15 feet, 20 feet, and 30 feet have been observed.]

Effect of the Fungus on the Wood.

The general effect is to reduce the wood to a soft, white, crumbly mass, lighter in weight than the healthy wood. In transverse section the medullary rays stand out clearly as thin, more or less unbroken lines traversing the disorganised woody tissues, and in a piece of radially-broken wood, they stand out in distinct patches. The cortex and bark of the rotten wood consist of little more than a mass of fungal hyphae. Evidently the mycelium secretes a cellulose-destroying enzyme. Frequently it is noticed that the cortex of the healthy side of the diseased trunk is also rotten; the mycelium advances much more quickly round the cortex than across the wood.

Tests performed on very diseased wood from the crack in a dead tree show that the summer-wood (autumn-wood) persists unaltered longer than the spring-wood. Of the various wood-elements, the cells of the medullary rays are the last to be altered by the fungus; this may possibly be correlated with the slow transverse

advance of the fungus. In most cases where the wood is almost totally destroyed, it is extremely difficult to obtain any evidence that reduction of the wood to cellulose has taken place. The tissues still give the characteristic wood-reaction with phloroglucin and hydrochloric acid. In one specimen, however, where some of the wood was in the last stage of disorganisation, no reaction for lignin could be obtained. In the parts of the material which were not quite so rotten, the walls, though thin, were still lignified. The summer-wood and the medullary rays were more strongly lignified than the rest of the tissues.

The hyphae are found very abundantly in the vessels and tracheides (Pl. III, fig. 1), and to a less extent in the medullary rays and wood-parenchyma. The fungus makes its way through the two first-named chiefly in the longitudinal direction, and this will account for the fact that one longitudinal half of the diseased region is rotten, while the other half is practically sound.

The hyphae pass from cell to cell through the pits (Pl. III, fig. 2), and often dissolve away the pit-borders, so that a thin area is formed. In some radial sections cases have been noticed where the pit-border is perfect on one side, but on the other side the thickening layers of the pit-border, and the part of the wall beyond, have been dissolved. (Pl. III, fig. 3).

In the vessels of some material, numerous small holes are seen which have no relation to the pits, and large holes in similar positions have been noticed in greatly disorganised wood. Evidently the fungus pierces the walls, in addition to passing through the pits, though the former seems to be the more general method of progress. Pl. III, fig. 5). The condition shown in Figure 3 may perhaps be brought about by the enlargement of a hole in the wall near a pit.

The effect of the fungus on the individual cell-wall is to bring about a gradual centrifugal reduction in thickness, till only the thin primary lamella remains. The first stage in wall-dissolution is the swelling of the layer of thickening which was last laid down, and in consequence, this often curls inwards at the pits. The pit is often the starting-point from which dissolution begins. It is difficult to show the stage at which the swollen layer is reduced to cellulose; probably the cellulose is dissolved away as soon as reduction has taken place. The thin wall-membrane which is left often remains intact, but in some cells it splits in the middle, and the split becomes enlarged, owing to the strain produced by the general shrinkage of the tissues. Disorganisation of the wood probably takes places in this way more than by the total dissolution of the cell-walls.

The disorganisation of the woody tissues proceeds relatively slowly with respect to the advance of the fungal hyphae through the tree. This may be correlated with the rapid longitudinal course of the fungus through the vessels and tracheides, and its passage chiefly through the pits. Often a considerable length of the tree is attacked, and fructifications are formed before any great destruction of the wood has taken place.

The diseased wood is entirely void of starch from a camparatively early stage. Tannin is absent at a later stage.

Curious products of decomposition are present in some of the wood. In material from one fallen tree they consisted of light or dark brown masses which filled many of the vessels and tracheides and covered the hyphae present in them. Brown "curtains" of tissue occurred in some of the vessels, giving the appearance of "tyloses," and greyish masses (soluble in alcohol) of a mucilaginous appearance were present in some vessels near the cortex. In another tree the wood near the fracture showed a dark-brown line across the diameter of the trunk. This was due to a very dark-brown substance which occluded the vessels and tracheides, and coated the hyphae (Pl. III, figs. 8, 9). The tissues on one side of the line were badly diseased, and very rotten near the cortex. On the other side of the line the wood was healthy, though there were some hyphae in the tissues quite close to the line.

The brown substance appears to have been deposited as a liquid, judging from the globular form of many masses, and the way in which they fill up the vessels. These decomposition substances may be similar to those formed by the advance-hyphae of other wood-destroying fungi.

Description of Hyphae in the Wood.

The hyphae vary very considerably in size and character. Those which traverse the pits and holes are larger and have more contents than those which are massed up in the vessels, though among the latter a few large hyphae are sometimes found. Most of the vessels are full of very fine hyphae, which are matted so closely that it is impossible to recognise anything clearly. The hyphae can be well studied in the tracheides and medullary ray cells, where they take a fairly regular course and give off branches which pierce the pits. In passing through a pit the hypha appears to swell up; this may be due to the action of an enzyme secreted by the fungus.

The hyphae are branched and septate, and have very typical clamp-connections. The larger-sized hyphae seem to be engaged

in transforming the contents of the cells, and the cell-walls, and absorbing them, the thin, tangled hyphae found in the vessels appear to represent the advance-hyphae, which mark the rapid longitudinal progress of the fungus through the tree. In very diseased material these hyphae are in a more or less exhausted condition. The hyphae are usually colourless, but, as already mentioned, in some material dark brown hyphae are present:—

(1) At the dark line near the fracture in one tree.

(2) Near the cortex of some very diseased wood.

Also brown hyphae have been observed in the wood immediately under the young fructification pustules on material kept for observation (Pl. IV, fig. 10). These hyphae are found in the fructifications as well as in the wood, and may perhaps belong to some other fungus which has attacked the material later. They are rather large, and split up into oidia in parts. Globules of a brown substance are present in some of the wood cells which contain these hyphae, and are similar to those found in the material in (1) and (2). Oidia-formation has been observed in hanging-drop cultures of hyphae taken from the inside of a fructification; hence there is a similarity in the behaviour of the brown hyphae mentioned here, and the hyphae of the fructification which accompanies the disease. Possibly oidia-formation takes place normally in the fruiting stages.

The hyphae of the mycelium which comes out on the cut surface of diseased wood under suitably damp conditions are very fine and closely woven.

Cultures.

Many cultures were made with the object of tracing as far as possible the life-history of the fungus which causes the "Snap-Beech" disease. As no spores could be obtained, cultures of the mycelium from diseased wood were used. For purposes of comparison, cultures were also made from hyphae taken from the interior of fructifications of *Polyporus adustus,* and also from a pure culture of *Polyporus adustus* obtained from Holland. None of these gave any signs of fructifications, though many differently nourished cultures were subjected to different conditions of light and moisture, and to sudden changes in the nature of the substratum (See a paper by Miss Elsie Wakefield, on "Die Bedingungen der Fruchtkorperbildung bei Hymenomyceten, sowie das Austreten fertiler und steriler bei denselben.").

In only one case was a connection proved between the mycelium in the beech-wood and a fructification of the *Polyporus adustus* type. Some small blocks of wood from the insides of the crack in a dis-

eased tree were put into damp, sterilised test-tubes. For some time there was no visible increase in growth of the fungus, but two months later the beginnings of fructifications were seen on the wood. The very young pustules were light brown in colour. The mature-looking fruits were encrusting, with a rather uneven surface of dark brown tubes, and were from $\frac{1}{4}$-inch to $\frac{1}{2}$-inch in diameter. No spores apparently were formed, though the material was kept under observation for a considerable time.

Blocks of diseased wood were kept under damp conditions under bell-jars, and the pure mycelium which crept out to the exterior of the cut surfaces was used for making cultures.

I. Small cubes of diseased wood were washed in .1 per cent. corrosive sublimate for a few minutes, passed through methylated spirit, and put into sterilised tubes. The cubes were kept moist by damp cotton-wool, and the tubes were sealed. After several weeks the mycelium emerged from the wood of some of the material and formed a luxuriant vegetative growth over the surface. It seems difficult to obtain exactly the right conditions of moisture to ensure growth of the mycelium.

II. Blocks of diseased wood were soaked in 10 per cent. KOH solution for ten minutes and transferred to gelatine cultures in Petri dishes. Two only, out of a number of trials, were successful. In these cases the mycelium emerged from the wood and formed a rich vegetative growth over the jelly and up the sides of the dish. Sub-cultures were made on to bread-media, and a rich growth was obtained in less than a month. Oidia were found in these cultures. The hyphae which had split up were larger and richer in contents than the others.

III. From pure mycelium diseased wood, cultures were made on gelatine in tubes. Sub-cultures were made from these on various media in Erlenmeyer flasks, including: (1) bread and sterilised water; (2) bread and beech wood extract; (3) bread and solution of meat extract. A rich vegetative growth was obtained in all cases; no fructifications were formed, though the cultures were subjected to varied conditions, *e.g.*, (1) drying the mycelium in an oven at 28° C.; (2) cooling in a chamber at 13° C.; (3) Exposing the loosely-plugged flask to a current of air, and thus inducing transpiration; (4) exposing the culture to the air; (5) exposing to various conditions of light.

IV. Many sub-cultures were made from bread on to gelatine and agar substrata of varying concentrations, in order to try the effect of suddenly starving the mycelium by transferring a few

hyphae to a smooth, firm substratum.[1] No fructifications were formed, though the growth was less luxuriant than in the original cultures, and though the cultures were subjected to various conditions.

V. Sub-cultures were made from bread on to a salt-agar medium, which Gorodkowa[2] found successful in inducing spores in *Saccharomyces cerevisiae* (1 per cent. agar, 1 per cent. peptone, 1 per cent. meat extract, $\frac{1}{2}$ per cent. common salt, $\frac{1}{4}$ per cent. glucose). The growth was very scanty, but there were no signs of fructifications.

VI. Some sterilised healthy beech-blocks were infected with mycelium from a bread culture. Two out of six infections proved successful, but the growth was vegetative, and very luxuriant. The wood was examined microscopically, and showed the same symptoms that are seen in wood of diseased trees.

VII. Hyphae from the interior of fructifications of *Polyporus adustus* were used to make cultures:—

(1) Hanging-drop cultures in water and various liquid gelatine media.

(2) Gelatine cultures in tubes and flasks.

(3) Bread cultures in flasks.

The cultures showed a rich vegetative growth, in every way similar to that obtained from the mycelium in the wood, except that the hyphae were larger.

The hyphae in hanging-drop cultures of 1 per cent. gelatine broke up very freely into oidia, chiefly at the ends of the hyphae, but also in intercalary positions. The oidia vary in length; sometimes very small and sometimes very large pieces are broken off, but the latter usually split up again. If a fructification is cut, or if small fragments are transferred to culture media, *e.g.*, hanging-drops, new growth is quickly made. The hyphae in the hanging-drop cultures are mostly unbranched, with the typical clamp-connections. Oidia-formation was seen in the older stages.

VIII. Numerous cultures of pure *Polyporus adustus* from Holland were made on various media, and were subjected to various conditions. There was a rich vegetative growth, and the hyphae were of the same type as those on the diseased beech-wood. The cultures were exactly similar to the cultures obtained from the mycelium in the wood. There was no sign of fructifications. Oidia-formation was seen in a culture on sterilised beech sawdust.

[1] See Miss Elsie Wakefield's paper.

[2] Gorodkowa. Bull. du Jardin imperial, St. Petersburg. Vol. vii, parts v and vi.

In all the cultures made on solid media, the fungus caused liquefaction after a time, especially in bread cultures. The liquid was yellowish-brown in colour. It may be that it is somewhat similar in composition to the light brown globules which were observed in some of the diseased beech-wood.

Experiments to Investigate the Enzymes in the Mycelium.

Some material peculiarly suitable for the investigation of the enzymes in the mycelium was obtained. Two blocks of wood which had been cut from the trunk of a tree killed by the disease had been put one on top of another, and between the closely-adhering cut surfaces the mycelium had formed a thick layer of about $\frac{1}{8}$-inch in thickness. This could be scraped off with a knife, and was quite pure. Buller's methods were followed in carrying out these investigations.

Varying degrees of concentration were used:—10 per cent., 5 per cent., and 33 per cent. of mycelium in the extract. The filtered extract was of a clear brownish colour, and slightly acid. Toluene or chloroform (chiefly the latter) was used as an antiseptic. Controls made by boiling the filtrate were always used.

1. *Diastase.* The action of the filtrate on starch solution was tested by iodine solution at intervals. The colour in the unboiled extract became less and less, and after a time no colouration was given, while the control gave the distinct blue colouration; therefore *diastase* is present in the mycelium.

2. *Invertase.* The effect of the extract on cane sugar solution was tested. After two or three days a distinct precipitate was obtained with Fehling's solution. Hence *invertase* is present in the mycelium. In this experiment the tubes were kept at a temperature of 28° C.

3. *Protease.* The tryptophane test was applied and the colour of the solutions was always compared with a standard one known to contain a proteolytic enzyme, viz., trypsin, whose action on Witte-peptone, or fibrin, was used. When Witte-peptone or fibrin were both present together with the mycelium extract, a distinct coloration was obtained with the bromine water in normal, acid and alkaline solutions. With Witte-peptone or fibrin alone, with the mycelium extract, there was no colouration when the bromine water was added. Hence the results are unsatisfactory, and give no proof that protease is present, though one would expect it to be.

4. *Tyrosinase.* The effect of the mycelium extract on saturated tyrosin solution was tested. The unboiled solution turned black

after 3-6 days. Neither the control solution, nor an unboiled extract of the fungus *without* tyrosin, showed darkening. Hence *tyrosinase* is present in the mycelium.

5. *Emulsin.* The mycelium extract, together with a 5 per cent. amygdalin solution, gave a very strong odour of hydrocyanic acid after a few days. *Emulsin,* therefore, seems to be present in the mycelium.

6. *Laccase.* The effect of the mycelium extract on a 5 per cent. solution of hydroquinone was tested, but there was no difference in colour between the unboiled and boiled solutions. *Laccase* is evidently *not* present in the mycelium.

7. *Rennetase.* Testing the effect of the extract on new milk, in one case the unboiled was quite solid in twelve hours, while the control was unchanged; in another there was no coagulation in either; but the unboiled solution had turned quite brown, while the control was unchanged. In other experiments it was difficult to distinguish between them; hence the results are unsatisfactory, and it is doubtful if *rennetase* is present.

8. *Pectase.* Pectin was obtained from ripe red-currants. The mycelium extract had no effect on the pectin solution. Hence *pectase* is *not* present in the mycelium.

9. *Cytase.* Though the mycelium apparently *must* secrete cytase, the mycelium extract had no effect on cotton-wool or cellulose tissue even, after several weeks.

Hence diastase, invertase, tyrosinase and emulsin have been proved to be present in the mycelium.

The Fructification of *Polyporus adustus,* Fr.

A large block of wood—the fractured end of the trunk—was kept under a large bell-jar in the laboratory, and the development of the fructifications was observed. The end of the block was partly covered with fructifications when it was obtained.

The fructification first becomes visible as a tiny white pustule of hyphae, which are rather larger than those on the wood, and which anastomose with typical clamp connections (Fig. 11). The pustule grows into the extremities and becomes yellowish in colour from the centre outwards, then light brown or greyish, and finally a greyish-brown. The shade of the mature fructification varies to a considerable extent. At first the fructification is encrusting, and it remains so for some time, even in cases where brackets are finally developed.

Sections taken through the edge of the encrusting fructifications show that at certain points on the surface hyphae have grown up and branched in a racemose manner. In the hollows between the tiny projections thus formed a new basidia, bearing usually 2-4 spores, have developed. Club-shaped hyphae are present among them, probably representing paraphyses. These beginnings of tubes are found to within less than an inch of the edge of the encrusting fructification; hence tube-formation begins early, though it seems to proceed relatively slowly.

Three types of hyphae can be distinguished in the young encrusting fructification :—

1. The large, multinucleate hyphae of the body of the fructification.

2. The smaller-sized, deeply staining hyphae at the growing edge of the fructification.

3. The very fine branched hyphae which compose the "projections."

The stage which appears to come next in the development of the fructification is the formation of "protuberances" from the flat surface of the encrustation. They are darker in colour than the general surface, and consist almost entirely of a mass of interweaving hyphae. There is a surface layer of very young projections similar to those found in the encrusting stage, and at the apex of the protuberance young tubes are cut through. Some basidia bearing spores are found at intervals in the surface layer. The tubes are lined with what appear to be basidia, but no spores can be seen. The protuberances are evidently formed by the growth in thickness of the middle part of the fructification at these points.

The fructifications vary in shape and kind according to the position in which they develop. In wounds or cuts on the tree, and over the fractured end of the trunk, the encrusting fructifications are formed. The fructifications on a fallen trunk are bracket-shaped, and stand out at right angles to the trunk. The tubes are developed on the upper surface of the brackets.

Evidently the "protuberances" are the first stages in "bracket-formation," and on their surface, shallow tubes are present.

Mature-looking fructifications of a brownish colour, with a layer of tubes $\frac{1}{3}$-inch thick, were examined, and sections were cut. There was a very regular surface inside the pores, the groundwork of which had very faintly staining contents. From the mass of tissue layer the basidia projected at intervals along the hymenium. They were formed either by the end of a hyphae which curled up at right-angles

to its length, or by a branch given off from a hypha. The basidia showed no signs of sterigmata or spores, though the apparent age of the fructification would lead one to expect that they would be present. The nuclear contents of the basidia could not be determined; they were very rich in contents and stained deeply.

No mature fructifications with tubes containing basidiospores were found. This is rather peculiar, since some basidiospores are found in young encrusting fructifications. One is led to suppose either that the fructifications were not obtained at the right season of the year in order to find spores, or that there is no development of basidiospores beyond the scanty one in the young fructification.

Infection of Living Beech Plants.

A series of experiments on the inoculation of young Beech plants and mature trees, with cultures of the fungus from diseased trees, and also with pure *Polyporus adustus* mycelium, was begun. Though these had yielded no positive results up to the time when I left England, Professor Groom subsequently found that infections of older stems succeeded. These successful infections were made by fragments of pure mycelia which were conveyed with antiseptic precautions on to artificial wounds made in the bark of branches about four inches in thickness attached to the lime trees. The mycelia were placed on the bared sapwood; and the wounds sealed with grafting wax. The mycelia developed in the sapwood, and showed the characteristic rapid longitudinal advance and slow transverse advance. Thus living sapwood can be infected by the mycelium: the fungus is a parasite.

From the close connection between the diseased wood and the fructifications of *Polyporus adustus*, Fr., as well as the development of imperfect fructifications of this type on diseased wood in the laboratory, and these infections of the living tree, it seems very probable that this fungus is responsible for the disease. Yet in the absence of spore infections the work recorded in this paper can be regarded as only preliminary, and paving the way for a fuller investigation of the disease.

In conclusion I wish to express my very sincere thanks to Professor Percy Groom for suggesting this subject of investigation, and for the constant help and valuable advice which he has given me during these investigations.

I also wish to thank Mr. M. C. Duchesne for his kindness in helping me to obtain material.

Summary.

I. Trees affected with the "Snap-Beech" disease break off at a more or less constant height of 15-20 feet from the ground, usually in a strong wind.

II. The lower part of the trunk and the upper part of the tree are sound, while the part between is diseased.

III. The fungus, in all probability, enters through a wound, and advances very rapidly in the longitudinal direction, but slowly in the transverse; hence one longitudinal half of the diseased region is rotten while the other is still sound.

IV. The disease is probably caused by the fungus *Polyporus adustus*, Fr.

V. [Infection experiments by means of mycelium placed on the bared sapwood of the living beech-stem gave positive results.—P.G.]

VI. The cortex and bark are reduced to a powdery white mass of little more than fungal hyphae. Of the wood elements, the vessels and tracheides are the first to be disorganised, and the medullary rays are the last. The spring-wood is disorganised sooner than the summer-wood.

VII. Dissolution of the walls of the wood elements proceeds centrifugally from the lumen of the cell. As soon as the lignified membrane is reduced to cellulose the latter is apparently dissolved away.

VIII. The hyphae enter the constituents of the wood chiefly through the pits, but also pierce the walls.

IX. Many culture experiments were performed with mycelium from diseased wood, but no fructifications were obtained.

X. The enzymes diastase, invertase, tyrosinase, and emulsin were found to be present in the mycelium.

BIBLIOGRAPHY.

1. **Boodle and Dallimore.**—Report on Investigations made regarding "Beech Coccus" (*Cryptococcus fagi*, Barensprung). Bull. of Miscell. Information, Royal Botanic Gdns., Kew. No. 8, 1911.

2. **Buller.**—The Enzymes of *Polyporus squamosus*, Fries. Annals of Bot., 1906, vol. xx, pp. 49-59.

3. **Gorodkowa.**—Bull. du Jardin Imperial, St. Petersburg, vol. vii, pts. v and vi.

4. **Massee.**—Diseases of Cultivated Plants and Trees, p. 387.

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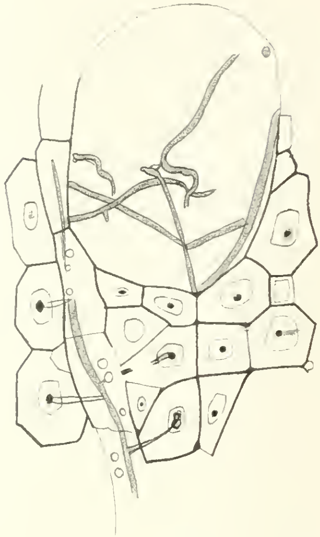

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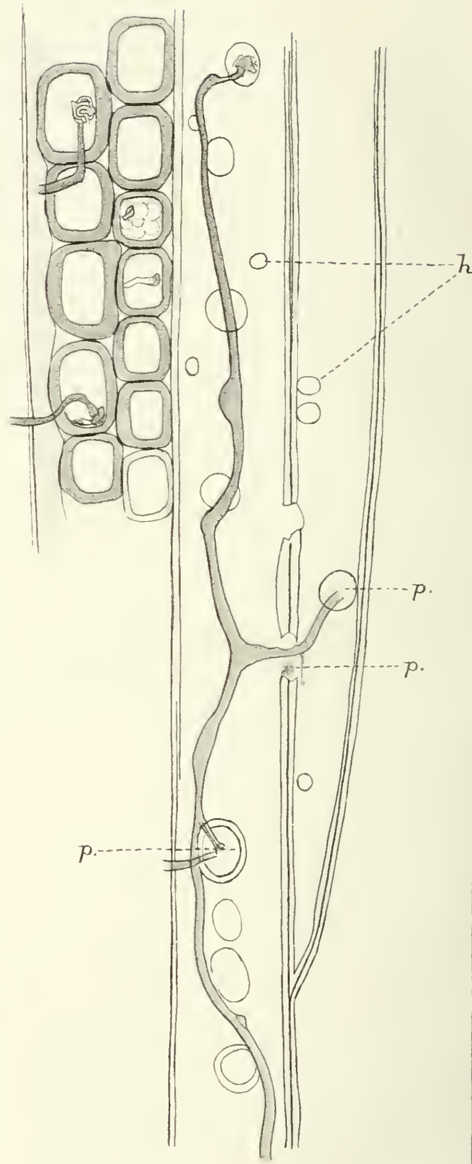

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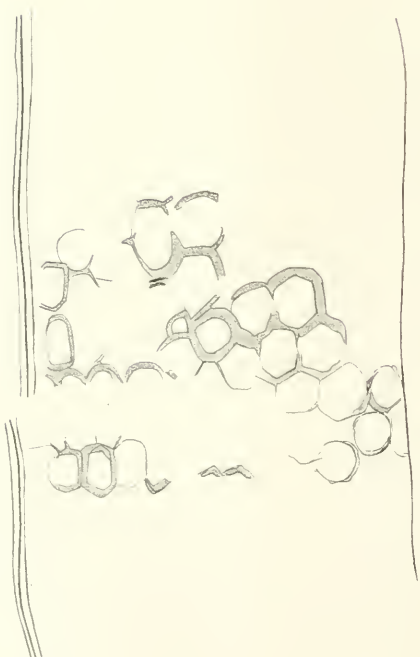

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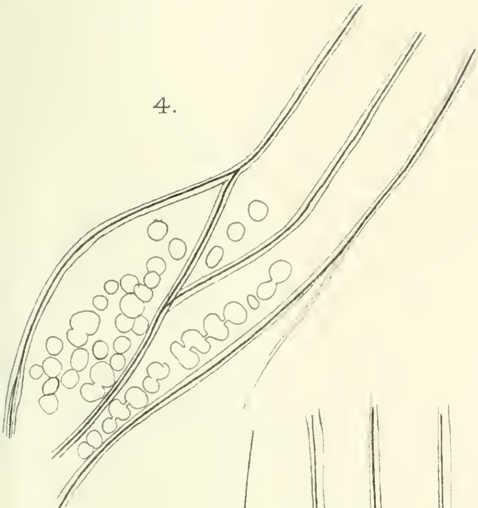

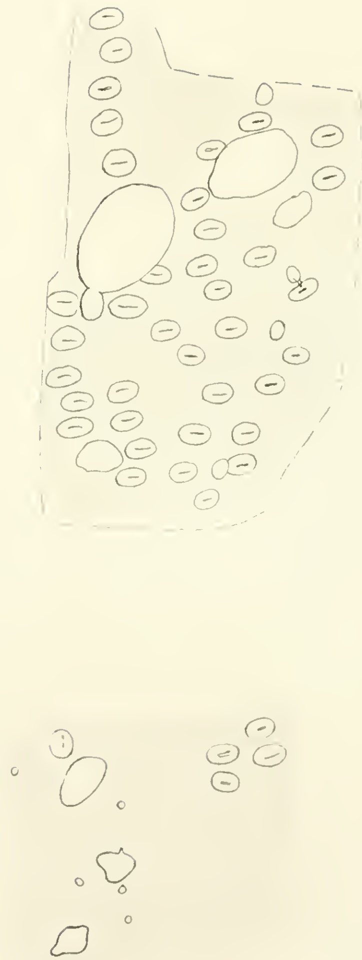

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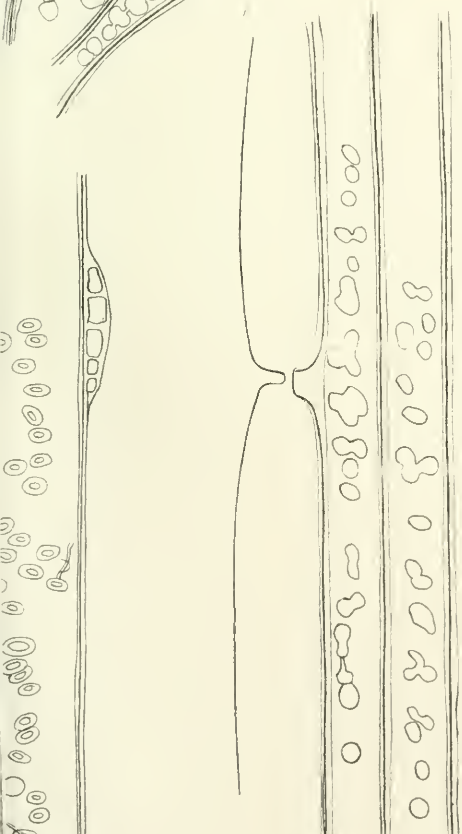

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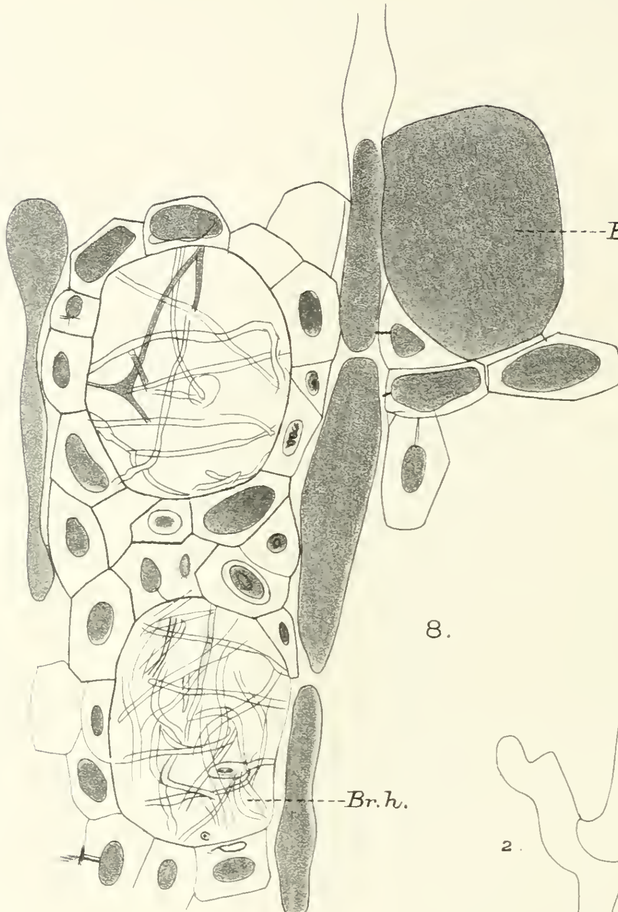

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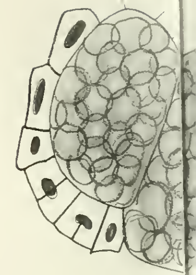

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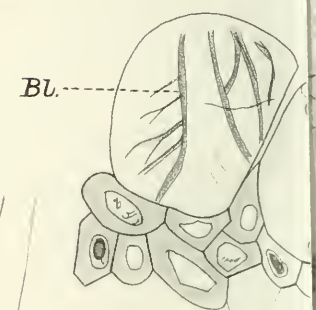

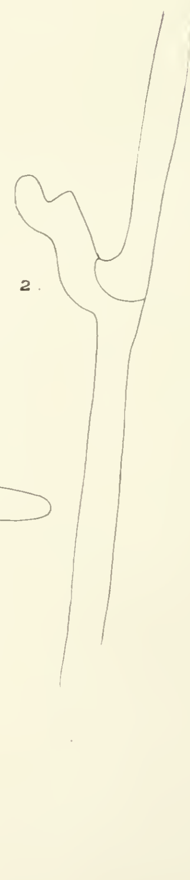

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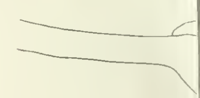

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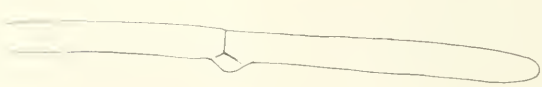

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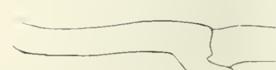

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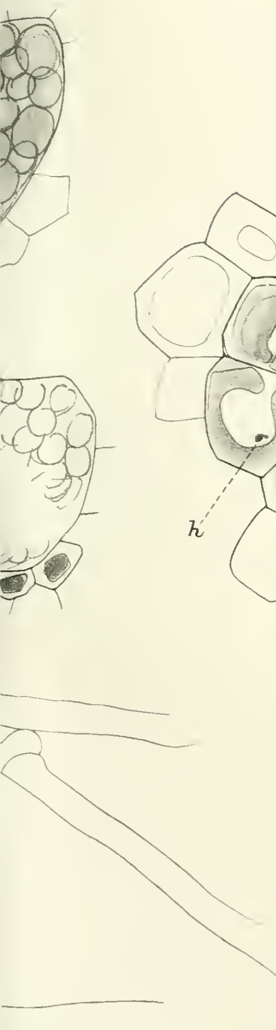

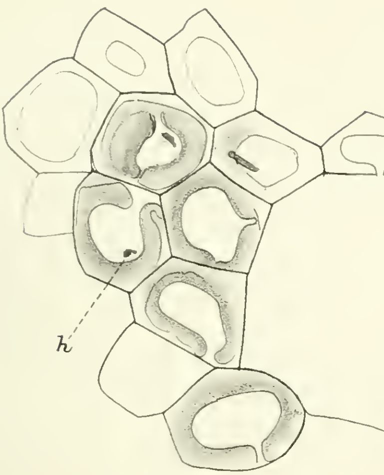

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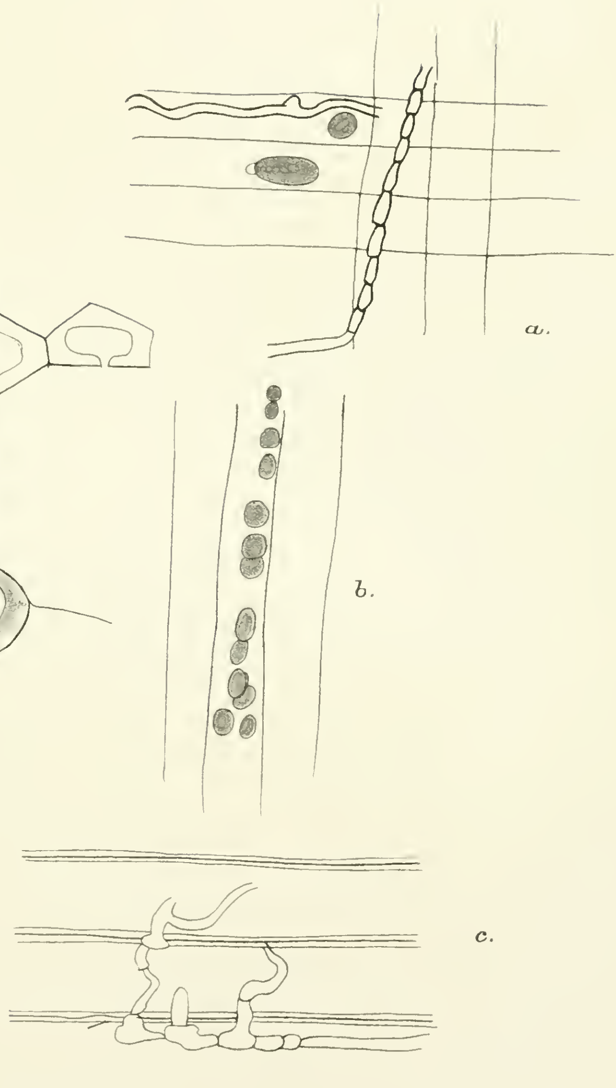

10.

" DISEASE.

Huth sc. et imp.

5. **Wakefield, Miss Elsie.**—Die Bedingungen der Fruchtkorperbildung bei Hymenomyceten, sowie das Austreten fertiler und steriler bei denselben.

EXPLANATION OF PLATES III AND IV.

Illustrating Miss E. M. Prior's paper on "Contributions to a Knowledge of the 'Snap-Beech' Disease."

Fig. 1.—Transverse section showing hyphae in the wood, which shows no signs of dissolution ($\frac{1}{10}$, 8).

Fig. 2.—Section of badly diseased wood, showing hyphae passing through pits (*p*) in the walls of tracheides and the formation of holes (*h*) in the walls ($\frac{1}{10}$, 10).

Fig. 3.—Hyphae in a wood-vessel, holes produced by hyphae and communicating with the aperture of the pit as if the hole had commenced inside the pit ($\frac{1}{6}$, 8).

Fig. 4.—Section showing destruction of the walls of the wood by the fungus ($\frac{1}{6}$, 8).

Fig. 5.—Section of very diseased wood taken from a "crack" of a fallen tree ($\frac{1}{10}$, 10).

Fig. 6.—Section of same wood as illustrated in Fig. 5, showing holes in the cell-walls produced by the fungus ($\frac{1}{10}$, 10).

Fig. 7.—Tangential section of a much disorganized portion of a medullary ray showing advanced dissolution of the cells ($\frac{1}{10}$, 10).

Fig. 8.—Cells at the dark line in the diseased wood, showing brown substance (*Br*) and brown hyphae (*Br.h*) ($\frac{1}{10}$, 10).

Fig. 9.—Section showing brown substance in the form of globules in wood-vessels and blocking the tracheides, also hyphae in the wood-vessel ($\frac{1}{10}$, 10).

Fig. 10.—Brown hyphae and brown globules in the wood under fructifications ($\frac{1}{10}$, 10).

Fig. 11.—Hyphae from the pustule representing a young fructification ($\frac{1}{10}$, 8).

Fig. 12.—Transverse section of beech-wood artificially infected in the laboratory, showing swelling of the inner lamellae of the cell-walls, exactly as seen in the wood of diseased beech-trees ($\frac{1}{10}$, 10).

REVIEWS.

The British Parasitic Copepoda. By Thomas Scott and Andrew Scott. Vol. i, pp. x + 256, plts. A and B. Vol. ii, pp. xii + 72 plts. London: The Ray Society: Dulau & Co., Ltd., 1913. Price 15s. and 25s. net.

The authors of these two volumes have long been recognised as authorities upon the Copepoda parasitic on fishes, and students of the subject will welcome their efforts to provide a monograph in which careful descriptions are accompanied by figures

We should have liked to have had a fuller and more detailed account of the morphology and development with figures of the same.

The classification adopted is that proposed by Gerstaecker in 1881, with some slight modifications. Of the seven families five species belong to the *Ergasilidae*, 32 to the *Caligidae*, 16 to the *Dichelestiidae*, one to the *Philichthyidae*, 13 to the *Lernaeidae*, 13 to the *Chondracanthidae*, and 33 to the *Lernaeopodiae*.

There are a large number of very useful figures, in a few cases, however, they appear somewhat wooden, and in many species the illustrations of structural details are very limited.

Flies in Relation to Disease: Non-Bloodsucking Flies. By G. S. Graham-Smith. Pp. xiv + 292, 24 plts. and 32 text figs. Cambridge: The University Press, 1913. Price 10s. 6d. net.

There already exist three or four works on the House-fly and its allies, and the author here has attempted to collect the most important and reliable information available on the subject, and to arrange it in such a manner that all who are interested in its various aspects may be able to ascertain the present extent of our knowledge. He has more than succeeded, for no previous work has given such a thorough treatment of the subject, or entered so completely into all the minor, as well as the more important aspects.

It is true that for many of the facts and observations he has been dependent upon other workers, all of which are generously acknowledged, but in addition to all this interesting matter there is a very solid contribution in the form of results of personal investigation of the highest importance. Such, for instance, are the chapters on the habits of adult flies, the distribution of bacteria, and flies and "specific" diseases.

In the author's own words, "the filth-carrying capacity and foul associations of the house-fly have been clearly demonstrated," and the publication of this work will, we hope, aid in creating a more enlightened view upon the subject by the lay public, and also help to remove the apathetic, if not actually antagonistic, attitude assumed by the medical profession.

The book is well illustrated, and there is an excellent bibliography.

Introduction to Biology. By Maurice A. Bigelow and Anna N. Bigelow. Pp. x + 424, 119 figs. New York: The Macmillan Company, 1913. Price 6s.

Professor Bigelow's introduction to biology, considered as science applicable to human life, especially in economic or practical hygienic lines, will undoubtedly fill a place where his *Applied Biology* is rather beyond junior students.

The authors have given a concise and lucid statement of the main facts of biology, and in such an interesting manner that much of the matter might well take the place of so-called "nature teaching." They are of opinion that a general knowledge of the structure, and especially of the functions, of a few well-selected animals and plants, viewed from the standpoint of applied science, is to the average citizen more useful than nature-study information concerning dozens of common organisms, and such chapters as those on Human Structure and Life-activities, Biology applied to Personal Hygiene, Organisms that affect Human Health, and that on the Economic Relations of Organisms, fully illustrate how fascinating such subjects may be made when dealt with by an experienced teacher.

We have read this book with considerable pleasure, and strongly recommend it to the notice of teachers.

Weeds. By R. R. Praeger. Pp. x + 108, 3 plts. and 45 text figs. Cambridge: The University Press, 1913. Price 1s. 6d. net.

Apart altogether from its educational value, and as the author justly remarks, "the preaching of the crusade against weeds cannot be begun too early," this is an admirable little manual. The author has wisely contented himself with wetting our appetite, and after a careful perusal of his work we decidedly want more, more of this fascinating study, so concisely and lucidly written, and so beautifully illustrated.

We hope future editions, and there is bound to be a demand for such, will not attempt to enter into the practical side of the question, *e.g.*, methods of extermination, principles of seed-testing, etc., but will rather add to the number of species here treated of and illustrated. Mr. Welch's photographs are excellent.

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Laboratory Methods in Agricultural Bacteriology. By F. Löhnis. Translated by W. Stevenson and J. Hunter Smith. Pp. xi + 136, 3 plts. and 39 figs. London: Charles Griffen and Co., Ltd., 1913. Price 4s. 6d. net.

The importance of the science of bacteriology in connection with agriculture has scarcely been realised in this country, and the courses offered in many of our agricultural colleges are totally inadequate. The need of a practical handbook has been generally felt, and teachers and students will welcome one bearing the name of Dr. Löhnis, the author of the well-known *Handbuch der landwirtschaftlichen Bakteriologie*.

The translators have wisely preserved as nearly as possible the style and methods of the original, which includes a general introduction to bateriological technique; dairy bacteriology; the bacteriology of manures; and soil bacteriology. We predict a wide demand for so excellent a guide.

Toadstools and Mushrooms of the Countryside. A Pocket Guide to the Larger Fungi. By Edward Step. Pp. xvi + 143, 8 coloured plts. and 132 figs. London: Hutchinson and Co. [1913].

Many of Mr. Step's books have attained a wide popularity, and this, his latest, is fully equal, if not superior, to anything he has yet produced.

In popular language the larger fungi are here described and beautifully illustrated; if only for the excellent photographs the works will form a useful and interesting pocket-companion to all country ramblers.

Evolution by Co-operation. A Study in Bio-economics. By H. Reinheimer. Pp. xv + 200. London: Kegan, Paul, Trench, Trubner and Co., Ltd., 1913. Price 3s. 6d. net.

The author emphasises the important part played by nutrition. "It is the bio-economic task of organisms to earn their sustenance, and over and above this to provide for marginal and exchangeable bio-economic values to be used in the mutual accomplishment of evolution." There is much in the work that is interesting, although the author's argument is not always clear. The work would undoubtedly have been increased in value if written in a more concise style, in some parts it is tedious to read.

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